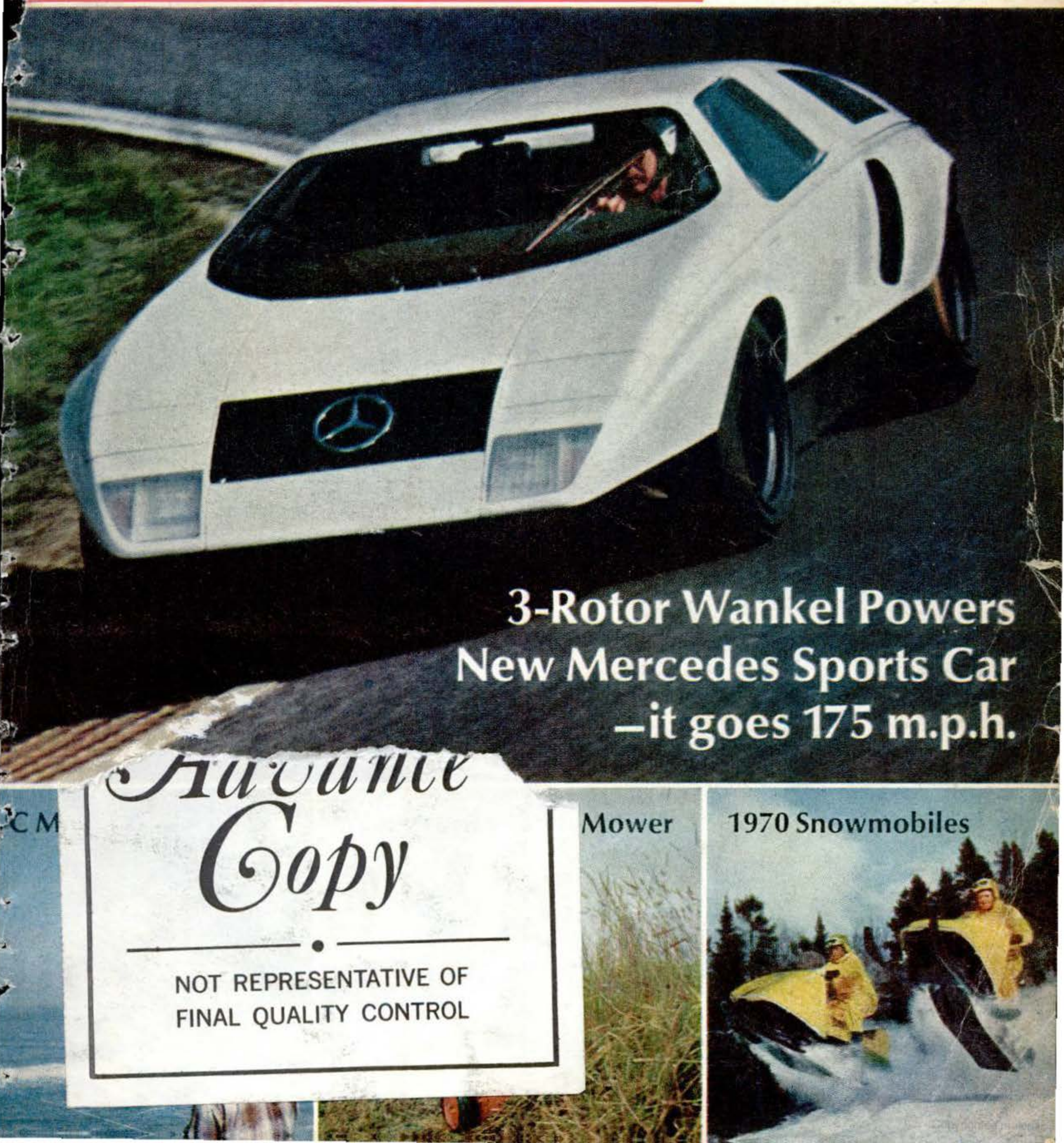
OCTOBER 1969 | 50 CENTS

Popular Science

THE *What's New* MAGAZINE

1970 CARS

- Compare Them in Color
- Complete Specs



3-Rotor Wankel Powers New Mercedes Sports Car —it goes 175 m.p.h.

Mower

1970 Snowmobiles

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OCTOBER 1969 Founded in 1872/Vol. 195 No. 4

HIGHLIGHTS OF THIS ISSUE:

Sensational New Mercedes Has Triple-Rotor Wankel PAGE 73

Exclusive PS report brings you the story of the most powerful rotating combustion engine ever installed in a car. This powerpack will give the sensational "Car of the Seventies" 175-m.p.h. top speed.

Vortex Mower Promises a Revolution in Grass Cutting PAGE 86

Your next power mower could be one like this. It uses a whirlwind to ease the job, and it's safe.

The 1970 Cars—Special 26-Page Section PAGE 96

Safer, cleaner, better: That's our verdict on the standard lines.
The brand-new cars: Chevy Monte Carlo—AMC Hornet—Dodge Challenger.
Full specs for 53 different cars . . . Plus 12 pages of color photos.

Get Ready for Winter Fun—Photo Guide to Snowmobiles PAGE 122

Bitten by the snowmobile bug? The new rigs stack up as the sportiest, most luxurious yet.

Now They're Flying Model Gliders by Radio PAGE 154

Remote controls have been fitted to the silent ones with results that delight ground pilots.

COVER PHOTOS: Mercedes—Julius Weitmann; model glider—Howard G. McEntee; vortex mower—Carl Howard; snowmobiles—Ozzie Sweet

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COMING NEXT MONTH

Want to know what's new? You'll find it in PS. Here's a quick look at what's coming in the November issue:

- Flying the New Jet Belt, by Robert Courter, Chief Pilot, Bell Aerosystems
- The Truth About Limited-Slip Differentials, by Jan P. Norbye and Jim Dunne
- Breakthrough in Underwater Breathing Systems, by Commander Scott Carpenter
- Suddenly, Everybody's on a Minibike! By motorcycle expert Jim Davis
- Snowmobiles Come to the Suburbs
- A Triangular Desk You Can Build (complete with blueprint)
- Those Silent Little Electric Trollers
- How You'll Survive "Fatal" Crashes
- Dr. Grosse's Wonderful Bubble Machine
- High-Speed Battery Charger—Will It Mean a Cordless Revolution?

PLUS: An exciting 14-page "What's New" section—ingenious new products . . . new tools . . . new for your car . . . for your home . . . what's new in electronics . . . in boating . . . and more.

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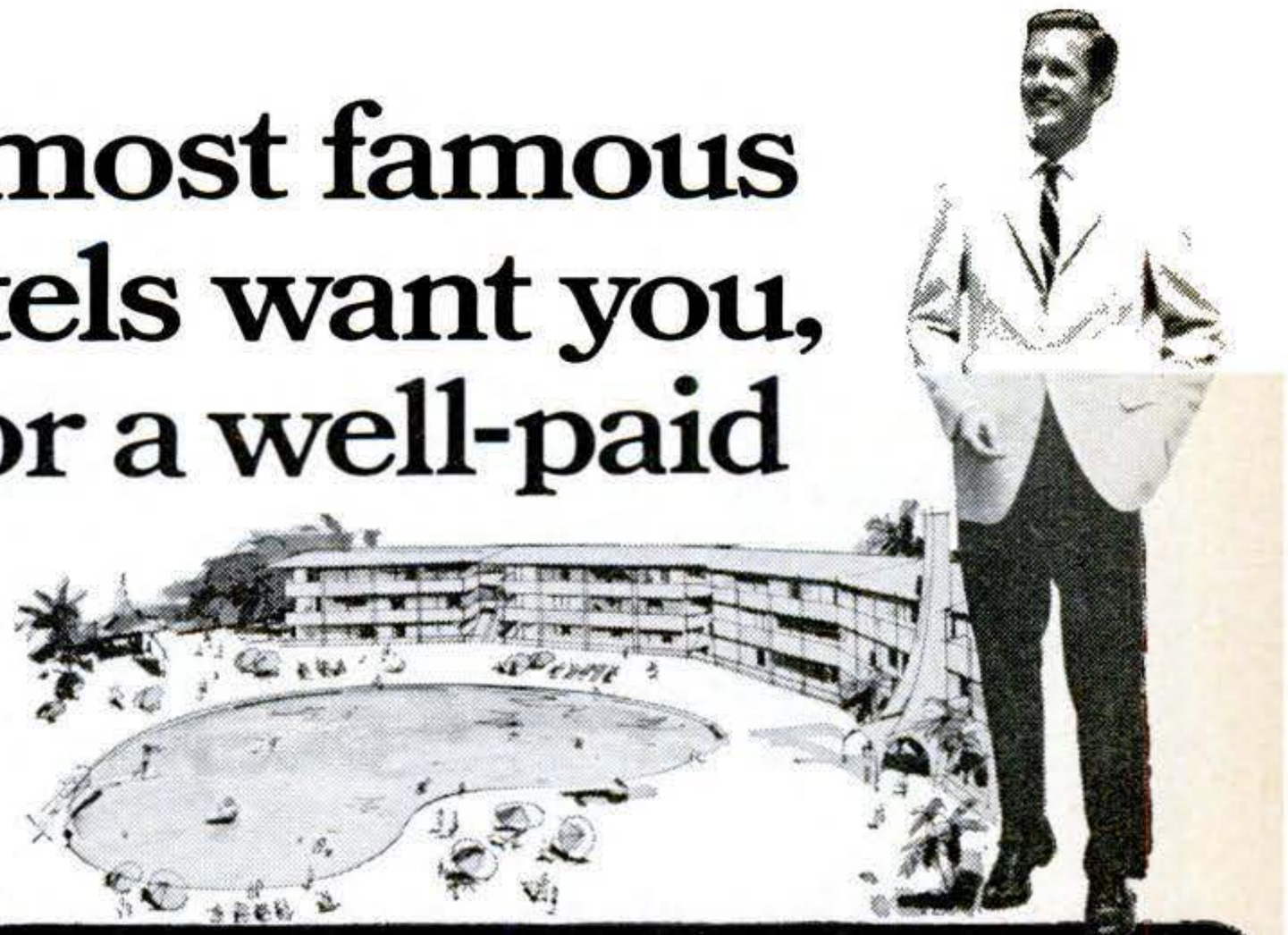

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PS Readers Talk Back

He read it here first

The photo below from the Orange County, Calif., *Register* shows an April 1924 story from PS on "A Rocket to the Moon." This and the May 1958 issue of PS in which Dr.

I. M. Levitt wrote of a "Timetable to the Moon" seemed like tongue-in-cheek reading at the time. But the recent exploits of Apollo 11 have been the most spectacular in my life.

CHARLES H. HARDY, Whittier, Calif.

. . . I commend you on the July articles "First Men on the Moon" and "How You'll See Mars Close Up." Thanks for all that information. I sincerely hope you will continue this coverage.

JAMES B. ENDRST, Pelham, N.Y.

Why an acre is as big as it is

In "Tile Pattern—New Math Discovery" [July], Arthur Earle has presented a beautiful and convincing explanation for our use of 360 degrees, 24 hours, 60 minutes, etc. An additional observation that he might have made is that when the pattern is extended to 120 rows it contains 43,560 tiles. It is easy to speculate that the Babylonians might have laid one-foot squares on the ground and, after having laid 120 rows, looked back and concluded that this was a convenient unit of land measure. I know of no other reason for the acre to have 43,560 square feet.

DAVID L. CHAPMAN, Tulsa, Okla.

Houseboat rentals

In a photo with "The Case of the Hospitable Houseboat" [July], you incorrectly described the docks and gas house shown as belonging to Delta-Cruz Houseboat Rentals. Actually they are part of our marina called Deluxe Houseboat Rentals.

HUGH DAVISON, Bethel Island, Calif.

Trailer brakes

While "What You Should Know About Trailer Brakes" [July] is generally quite complete, there is one item I find extremely disconcerting. You say "if the trailer breaks away, it rips off the connecting hose, letting car brake fluid escape." This is definitely at variance with the way our system works. It is based around a slave cylinder attached to the car brake line and a coupler mounted on the frame of the trailer. This slave cylinder is attached to the Stromberg coupler and held on the coupler by a handle which clamps on the ears of the slave cylinder. Should the trailer jump the hitch, the breakaway chain attached from the coupler lever to the towing vehicle will release the coupler lever, applying the trailer brakes and releasing the slave cylinder at the same time. At no time should the slave cylinder be torn loose from the hose, permitting fluid to escape.

WILLIAM T. SALAM, President
Stromberg Hydraulic Brake and
Coupling Co., Chicago

Caution words for diggers

A word of warning on digging your own well as reported in "How to Air Condition Your Home with Well Water" [July]. This could cause electrocution to unaware diggers, because digging with long sections of pipe

can be very dangerous due to the chance of electrocution from overhead wires. This happened near here not long ago.

ROBERT NEPPER, N. St. Paul, Minn.

. . . Edward F. Luscinskas suggests increasing the volume of air flow through the ductwork by increasing the fan speed. This suggestion may bring grief to some readers who build his system, particularly if the motor driving a furnace fan is marginal for the job. The power required to drive a fan varies approximately as the cube of the fan speed. This means that an increase of only 10 percent in the fan speed increases the power re-

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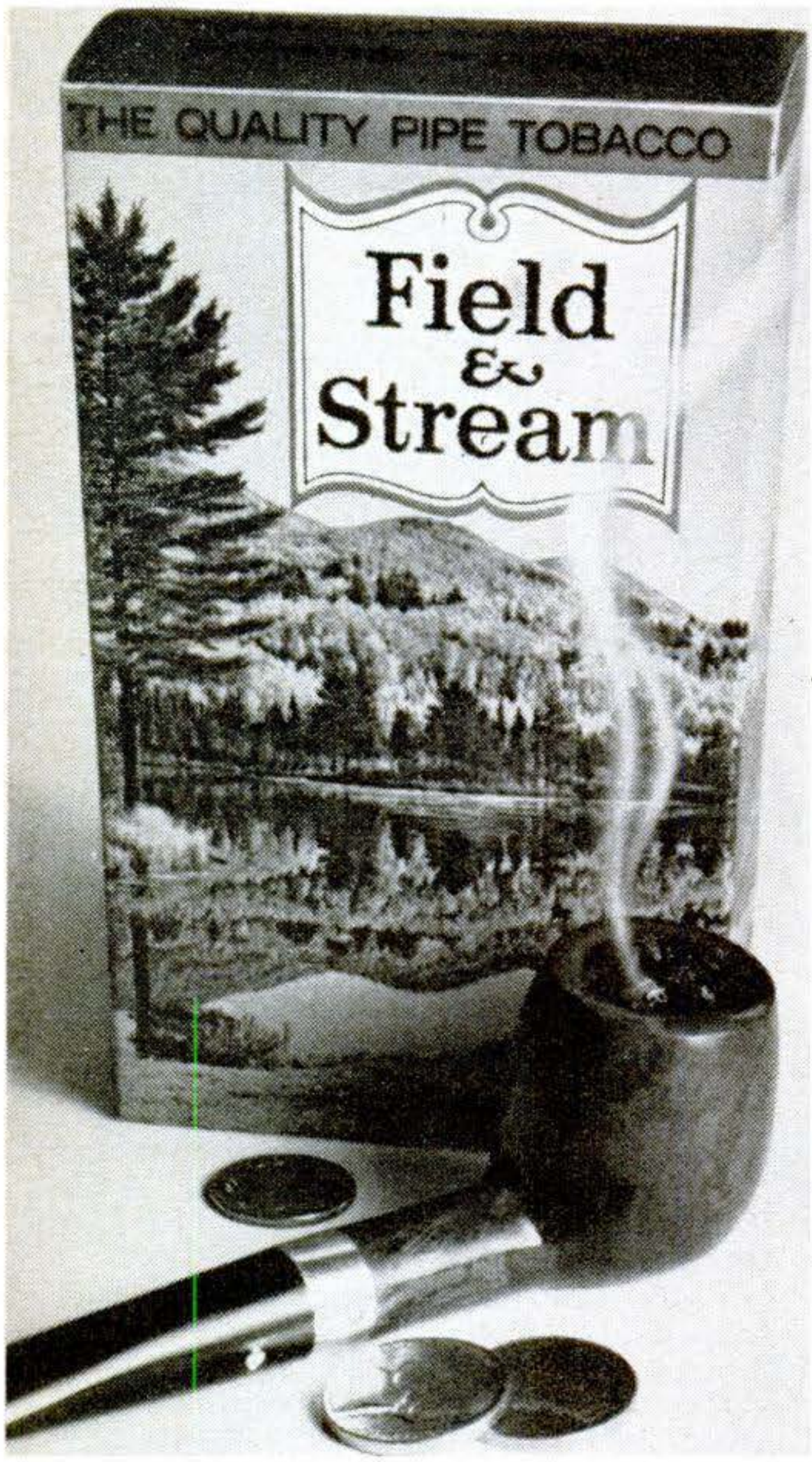

start saving up the dowry.

A quality product of Philip Morris U.S.A.

PS Readers Talk Back

[*Continued*]

quired to drive the fan by approximately one-third. If the motor is not sufficiently large to take care of the additional load, it will not be able to drive the fan at the desired speed, and more seriously, may even burn out.

CHARLES E. WILLBANKS, Tullahoma, Tenn.

Launches his workshop project

Here's a photo of the "Canoe Built From Siding" [Nov. '67] that I made by following

plans in your magazine. I was very pleased with the results.

ROBERT J. PRUCKNICKI, Maple Hts., Ohio.

Builds gadget to measure bullet's speed

I built the chronograph described in "Measure the Speed of a Bullet with This Electronic Stopwatch" [July] and it works very well. I also checked it with an Oehlert chronograph and it is very accurate.

One problem I had was finding an inexpensive conductive paint. The only one I have found costs $24 for two ounces!

WALTER HASS, St. Louis, Mo.

GC Print Kote copper paint (Lafayette Catalogue No. 13 T 6114) is $1.91 for two ounces.

Bargain flying

Norbert Aubuchon in "Flying the Yankee" [July] says American Aviation is building the lowest cost all-metal airplane in general aviation—$7,295 for a two-seater. He sure never saw the fine BD-1 from Bede Aviation, Springfield, Ohio, which is built with the same jet-age materials and performance. It's also fully aerobatic, but only costs $3,800 with the same 108-hp. engine.

GILLES CARIGNAN, Cap-Madeleine, Que.

Likes his overdrive

I read with interest "New Overdrive Unit Fits Auto-Transmission Cars" [Aug.]. Six years ago I replaced the 4.55 rear axle with a 3.54 axle on my 1953 Studebaker with V-8 engine and overdrive. The combination gave

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Duck hunters are tough customers. We like 'em.

Ask a diehard duck hunter why he shoots a Browning A-5. He might surprise you with his answer.

Probably, he won't even mention the sharp checkering and hand engraving. Or the select French walnut and handsome bluing. More likely, he'll tell of days when cold rain turned to stinging sleet. Or days when the snow blew so thick you could hear their wings whistlin' before you saw 'em.

And what he'll tell is how that Browning seemed to enjoy bad weather. Because the mechanism's design is not complex — fewer working parts to get out of adjustment. Because the gunmaker gave the same attention to detail on the inside as he obviously did on the outside — no shallow heat treatments, no loose fit, machined steel parts.

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PS Readers Talk Back
[*Continued*]

excellent performance. At 70 m.p.h., my speedometer reads 55, with the engine running very quietly. My car has traveled 156,000 road miles, with the pistons, rings, crankshaft, and bearings never having been replaced. Oil consumption is at a minimum.

In order to have positive control over the engagement and disengagement of the overdrive, I installed a separate ground circuit to the dash. In this manner, I can manually either engage the overdrive before the governor switch would allow engagement, or hold the overdrive in engagement after the governor switch has opened.

W. W. DEGENHARDT, St. Louis, Mo.

Brake-lining categories

In "Brakes for Your Car" [Mar.], Johns-Manville WK linings were incorrectly described. They should have been categorized as "All Purpose." JM makes no linings to fit the author's description of cheap-lining category, as they are *all* dual-friction linings compounded of high-grade full-molded brake materials. Our different grades vary only as to expected length of normal wear and not with relation to quality of friction materials used or excellence of their manufacture.

S. V. LUKAS, Johns-Manville, New York, N.Y.

Hooray for commuter car

It was with some exultation that I read "Commuter Car with Hybrid Drive" [July]. It revived memories of the Woods dual which was the car that was most fun to drive. The GM car also stirred hopes that perhaps the time is not too far off when we will get a sensible and practical car for use in our megalopolitan areas. We commuters have been harassed too long by having our streets, expressways, and atmosphere clogged by our present monstrosities. The package presented in the XP-883 seems about ideal in size and accommodation, as well as having attractive styling. My only criticism is that it doesn't have an air-cooled engine, which would simplify things and save some weight.

B. F. WALBURG, Bradenton, Fla.

Likes a fun house

I liked your fine article, "Way-Out Fun House for Your Vacation Lot" [July]. It really shows how to put things together and the materials you need. The blueprint will help anyone build it.

CHRISTOPHER W. THOMAS, Providence, R.I.

Want to get something off your chest?
Write "Readers Talk Back," POPULAR SCIENCE, 355 Lexington Ave., New York, N.Y. 10017.

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From family car to class D champion.

(With a great new motor oil)

Horace Klose bought his NSU TTS in Germany in 1967. He and his wife Marianne took it all over Austria, Switzerland and Germany. More than 5,000 miles on some pretty tough roads, with two up and luggage. Then they brought it home to Cleveland and Horace decided to race it.

He put in racing shocks and modified the exhaust and carburetion. Otherwise the car was completely stock. But it was getting 100 hp. out of only 61 cubic inches. Horace called it his "mini-monster" and that's just what it turned out to be. In 1968, it won five firsts and four seconds in National Class D races, with no DNF's. Which was more than enough for Horace to walk away with the Central Division Championship. This year he's moving up to Formula Ford.

The NSU engine revs to 8,000 and it's air-cooled, so it tends to run hot. Horace needed a motor oil that could really take punishment. He found one—Gulfpride® Formula G.

Formula G has come through two years of the toughest kind of racing without a single lubrication problem. It's won the World Manufacturer's Championship at Le Mans and the Can-Am Challenge Cup series. This year it outlasted everyone to win Sebring. It's the best protection against wear and overheating you can buy.

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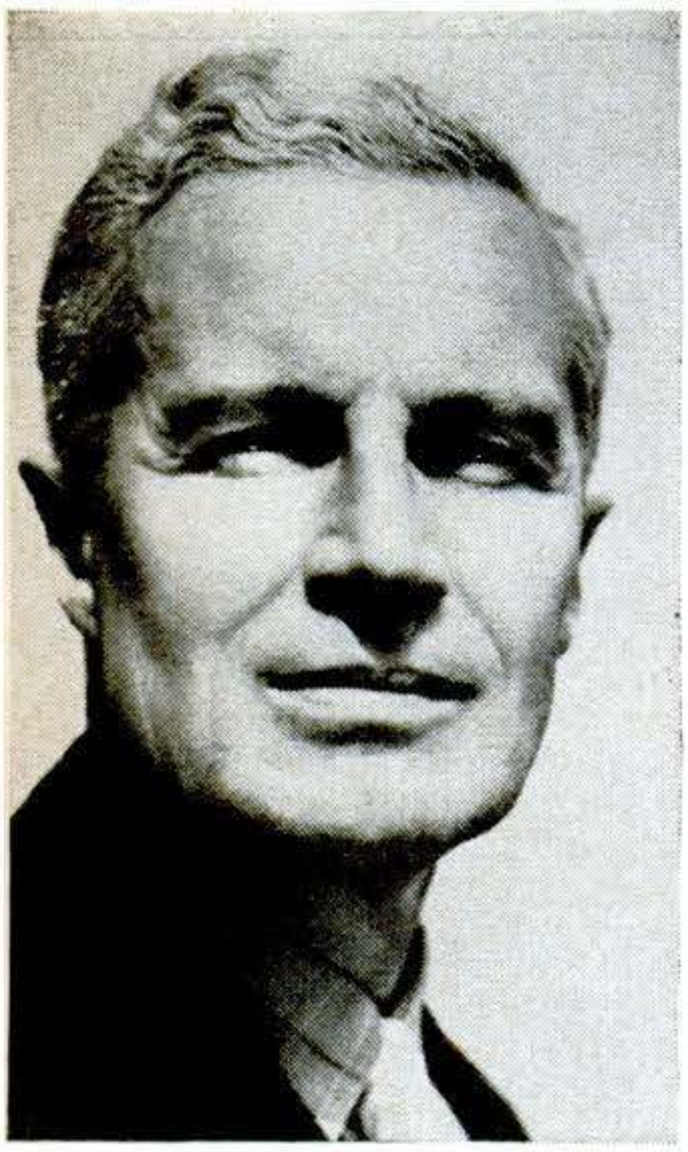

I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be — today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish!* And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned!* I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest $15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

VICTOR B. MASON
1512 Jarvis Ave., Suite M-3-LS
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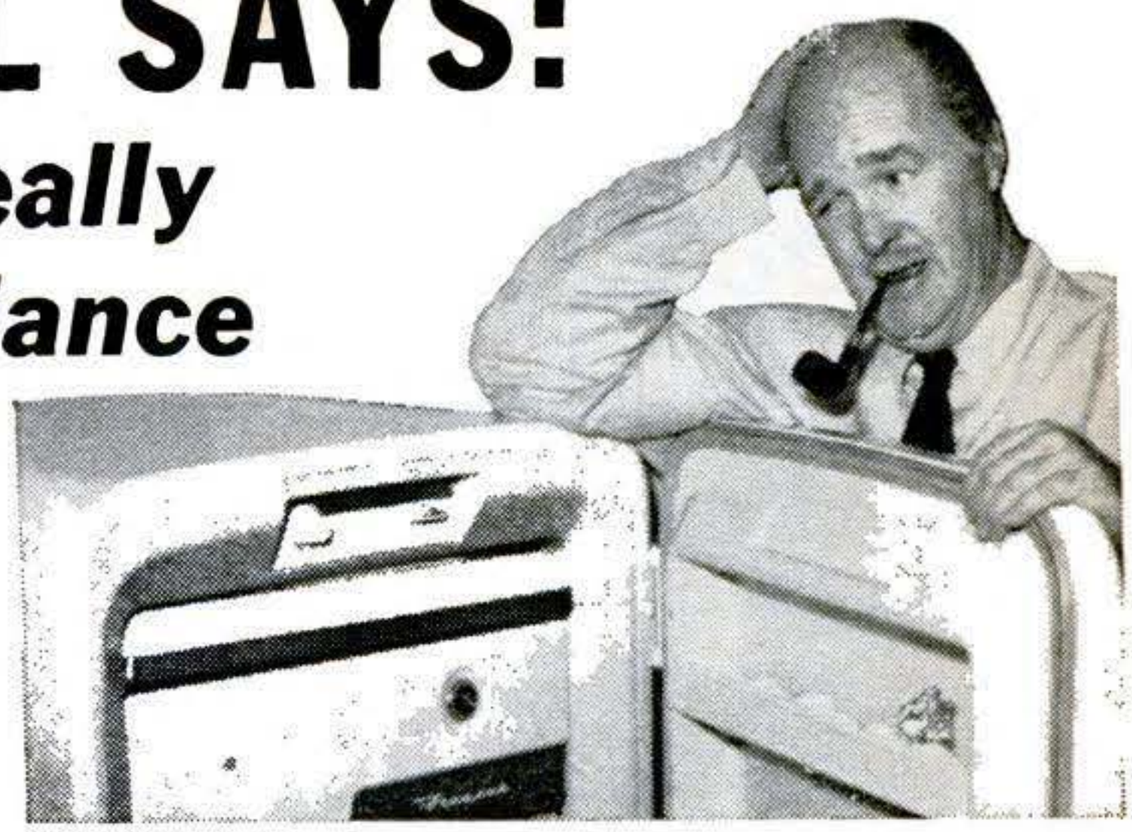
TOM McCAHILL SAYS:

"A Smart Guy Can Really Clean Up in the Appliance Repair Field"



Those electrical gadgets you have around your house are great on convenience, but if you're like a lot of do-it-tomorrow Johnnies, you don't know where to turn when one breaks down. So you call one of the busy Appliance Servicemen in your town, then drink instant until that fancy automatic coffee pot is perking again.

People have so many electrical appliances, it's no wonder Appliance Repairmen are busy as a bear in a bee nest. Count yours. The average home has at least a dozen, maybe more. There are better than 800 million appliances in the U.S.A. right now. No wonder the man who knows how to service appliances properly is pocketing $4 to $6 an hour, for as many hours as he cares to work!

If you're interested in making money (and who isn't), here is a job field crying for good men. And it's no sweat at all to get the training you need. Thousands have trained with National Radio Institute's Appliance Division. NRI has a great, low-cost home-study program covering every type of Appliance repair in detail. You study at home, in your spare time, learning through actual practice how to fix home, commercial and farm appliances. And not just the little stuff, either. Besides cantankerous coffee pots and toasters, you can learn how to repair air conditioners, refrigeration equipment, even small gasoline engines—and that's where the big bucks are, in the major appliances you'll fix.

NRI is one of the biggest and best schools in the home-study field. They have this Appliance Servicing course worked out to the most nit-picking detail. Yet, you'll be amazed at how little it costs. You even get a 25-buck professional Appliance Tester without extra cost. With your Tester and a few basic tools you probably have in your house, you'll be doing repair work long before you finish the course. And you can work anywhere—in a corner of your basement, in the garage, even on the kitchen table.

NRI has been in home-study education since 1914. Experienced, well-trained instructors on the staff of 150 in Washington, D. C., give you all the personal attention a man could ask. You don't even need a high school diploma. Take it from Uncle Tom . . . this can be one of the easiest and most rewarding businesses you'll find today, either full-time or in spare hours. As a matter of fact, knowing how to service Electrical Appliances can pay off even if you don't want to strike out on your own. That coffee pot on the fritz probably needed ten minutes of a repairman's time to be perking again like the mudpots in Yellowstone Park. You can do it yourself with the training NRI gives you. And if you're thinking about Social Security years, this is a great way to pick up some money and keep yourself busy at the same time.

There's nothing to lose except a postage stamp and the energy it takes to walk to the mailbox. What you'll get for your efforts is the newest NRI Appliance Servicing catalog. Nobody is going to ring your doorbell to pressure you into signing an enrollment blank. NRI doesn't employ salesmen.

Do yourself a favor and mail the coupon now—before you turn this page.

Tom McCahill

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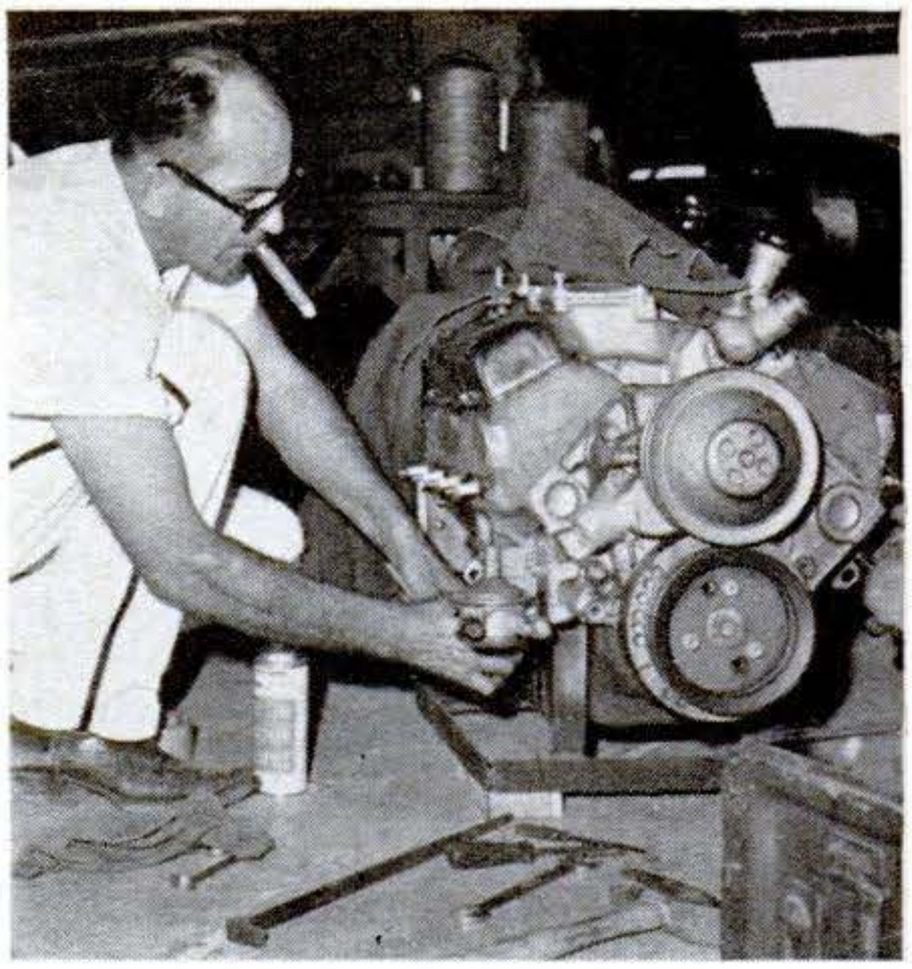
"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Ask Smokey. You'll find the address at the end of the column. Please *print* your name and address.



The automatic transmission in my '69 Ford LTD has a noticeable whine in first gear. The dealer claims it is normal with the heavy-duty transmission used with my 428 4V engine. A friend's similar model has no such noise. Can it be eliminated?

WILLIAM D. SUHR, Omaha, Nebr.

I have one, and it's as quiet as a mouse. If your dealer can't correct this, try a short descriptive letter to the Ford Motor Company. I am sure you'll find they have the answer and will remove the noise.

I bought second-hand, at 24,000 miles, a Jeep Wagoneer 1963 model, with four-wheel drive, limited-slip differential front and rear, and Warn hubs. It's impossible to get it out of four-wheel drive unless I stop and back up four to five feet. I had the shifting-linkage arms and transfer-gear's shift pin replaced, but no help. The mechanic who did this noted on the gear housing that the rear end was 4.09 ratio, but the front is 4.10. He maintains that is the reason she binds in four-wheel drive. The Jeep factory outlet here says they come through from the factory like that, and that if they came in the same ratio they would cause a whip and lash and lots of vibration in four-wheel drive. Is this a factory goof, and are they trying to brainwash me?

JOHN E. BAKER, Pittsburgh, Pa.

I think by this time the boys at Jeep know what they're doing, and don't have to apply Mao's pure thoughts to customers. What to look for is tires of different diameter at front and back—not the numbers printed on them, but the true size by measure. Too much difference between front and rear is bad—limited slip or no. Other things that can cause this trouble are poor clutch release, dragging brakes or incorrectly adjusted brakes, and an improper load on the shift rails.

I bought a '65 Mercury Commuter station wagon with 25,000 miles on it, and immediately installed four new General Jet Air tires on it. I did not rotate them. After 14,000 miles, the front ones had ample tread left, but the rear ones wore through the tread on the inner sides and both blew out. The mechanic at the tire company told me the rear axle housing has sagged in the middle, which caused those tires to fail that way. He said the housing must be replaced at a cost of $110 or more. Any other remedy? Also, the car uses a quart of oil every 200-300 miles. The only trace of oil on the garage floor is beneath the vent tube, and the exhaust only blows smoke when first started.

FRANCIS J. GRITZER, Miami, Fla.

A good mechanic and a Bear alignment rack can straighten the rear housing, but if you load the wagon down it'll bend again. Best cure is a heavy-duty housing. My guess on that excessive oil consumption is sticking piston rings, and the only real cure for that is an engine overhaul.

Has unleaded gasoline any advantage over leaded gas?

ADOLPH I. HEISLER, Bronx, N.Y.

Unleaded-gas manufacturers say leaded is N.G., and the leaded-gasoline boys say the opposite is true. Actually, they have put out so many contradictory statements that

Continued

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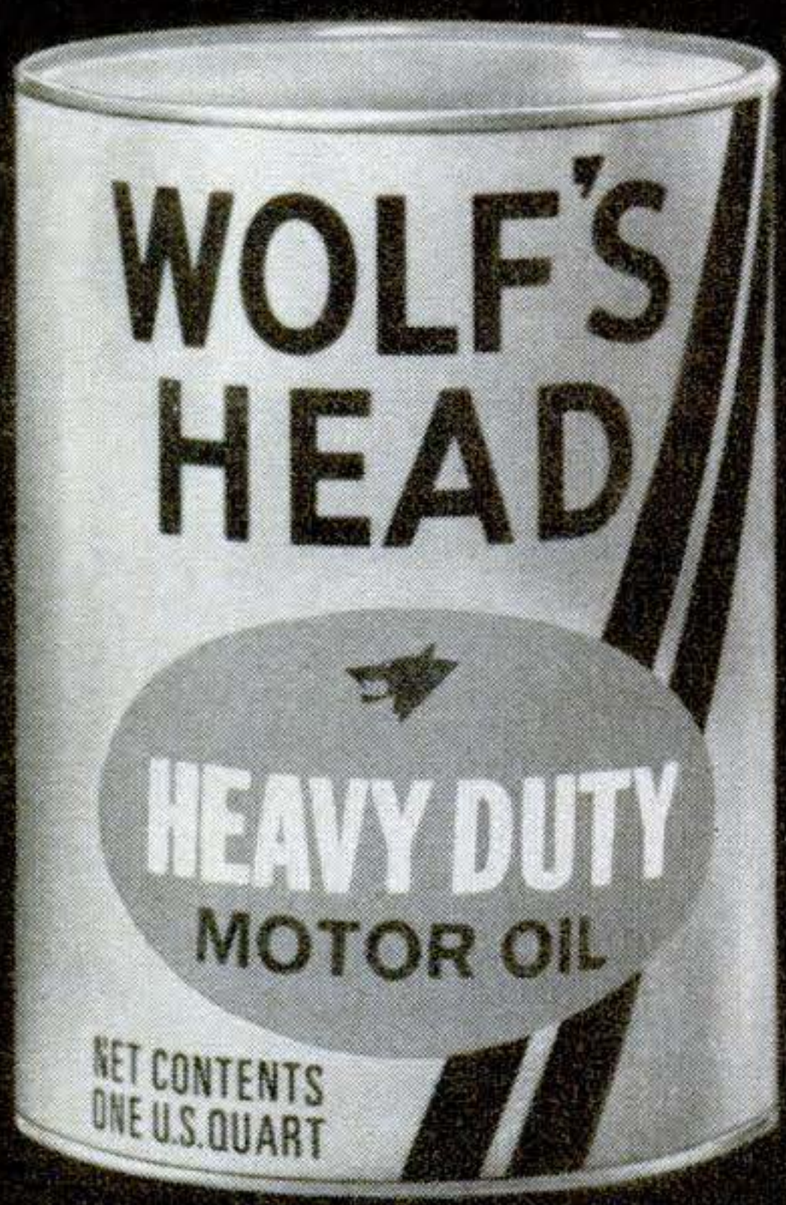

the uncommon motor oil

Exceeds car makers' warranty requirements.

"Say, Smokey—"

[*Continued*]

I think there isn't much difference either way. It appears to me that providing you stick to the proper octane or lab number for your particular car, you'll be on the safe side with or without.

A month after I bought it, my '68 Rambler American six with automatic started idling rough or cutting out entirely. From a standstill the engine would cut out at about one m.p.h. Six months later it began backfiring. Tapping the carb by the float made it start again, proving the float was sticking. Installing a new carb made it about 100 percent worse. A new manifold made it run fair for about 30 minutes; then it began to run worse than ever. Being still under warranty, I had the dealer check it out. The mechanic set the points and timing and unfroze the manifold heat-control valve. It ran good for a little while, then was as bad as ever. Every time a mechanic works on it, it runs better a few minutes, then worse!

HERSHEL L. BUGG, Wilmington, Ohio.

Sounds like you have had your share of car troubles. Rough idle and backfire through the carburetor can come from spark-plug misfire because of a cracked distributor cap, or sticking points, wire problems, wrong plugs. Other causes are too lean mixture, or leaking vacuum and/or fuel at the carb. Also look into sticking valves or a leaking intake manifold.

How about the advantages or disadvantages of the various methods of spark suppression in an ignition system? Which is better: Resistive wire with ordinary plugs? Copper wire with resistive plugs? Copper wire with a resistor in the line and the use of ordinary plugs?

R. K. HARVEY, Lawrence, Mass.

As far as I'm concerned, each Detroit manufacturer has the best combination for his particular cars, and installs it. Going into your question in detail would be too lengthy for this column, but here's a rough answer: Use a plug wire with very little metal and well-shielded, accessories well grounded, current-carrying wires shielded and with built-in resistance as necessary to stop feed-back.

Got a question on autos? Send it to:
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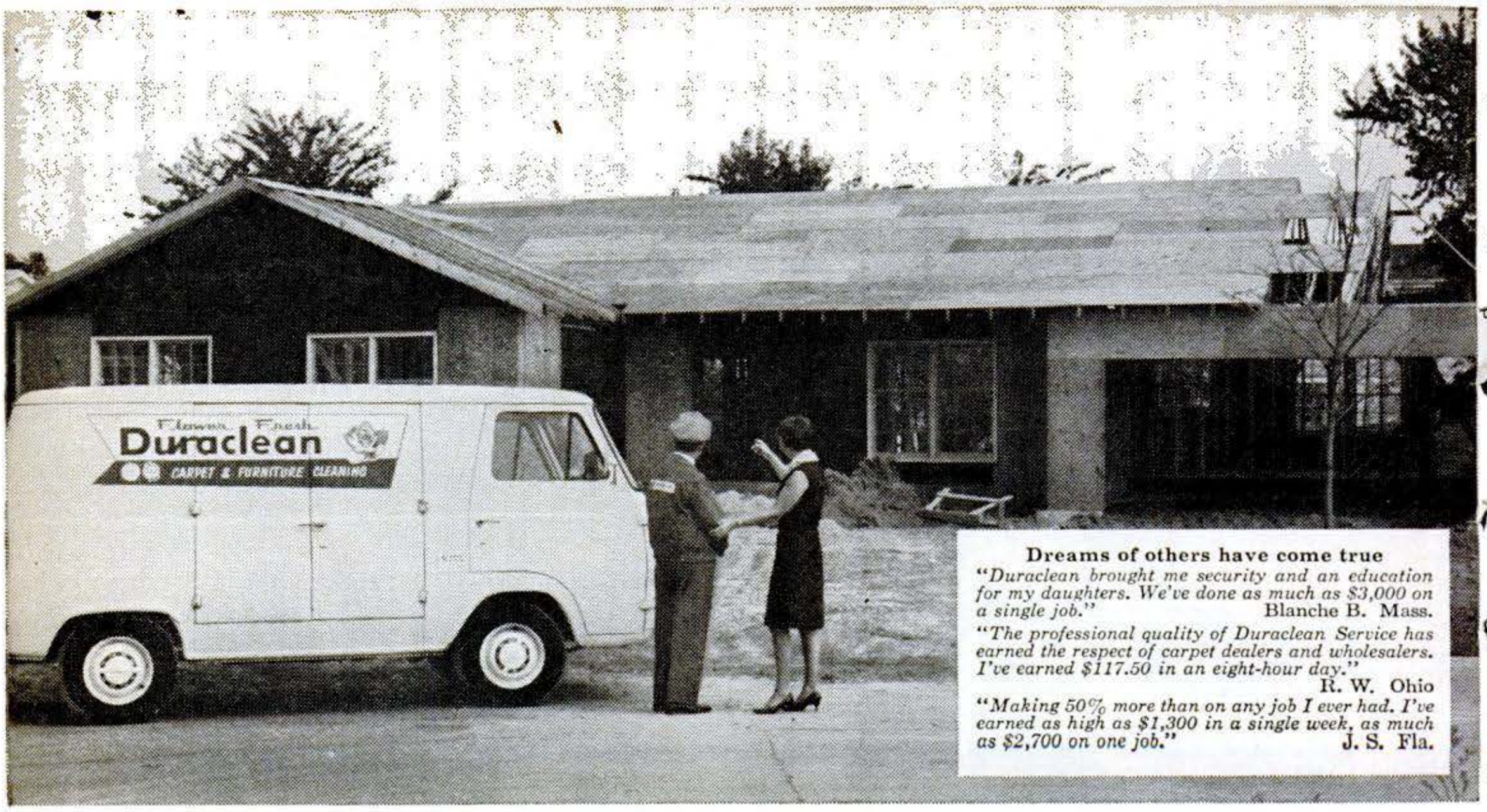

Dreams of others have come true

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"Making 50% more than on any job I ever had. I've earned as high as $1,300 in a single week, as much as $2,700 on one job." J. S. Fla.

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Hundreds of men—previously working for salaries or wages—now enjoy greatly increased incomes, personal independence, and secure futures as owners of their own businesses under the Duraclean Franchise

Unthinking men may tell you that the day is past when an individual can build a successful business of his own. The fact is that Franchising has opened a wonderful new world of opportunity for such men. The "mama and papa" grocery store, and the corner druggist have succumbed to the gigantic chains. But, in their place an exciting new kind of business abounds with big profit opportunities for the individual.

For twenty years the "service industry" has been growing with fantastic speed. Let the chains have the retail store business. Even a small business providing an unusual service can bring profits to the individual that were unheard of in the old days. And, unlike the chains, the service business today, is thriving under Franchising.

What is the difference? Just this: A chain is a large number of stores in a chain all operating under the same plan; under the same well-known name; *but* are owned by one corporation. In Franchising, the individual uses tested and proven plans for starting his business and building it; he operates under a Nationally Advertised and well-known name, he has step by step guidance *but he owns the business.* He enjoys the advantages of chain recognition, but he keeps all the net profits for himself.

The Duraclean Franchise is such a business. No store to rent. No fixtures to buy. No inventory or stock of goods to pay for. No office or work-room required. And, no special education or experience is needed for success. Men of almost every educational level have made glowing successes with the "know-how" furnished by our Company. They've worked from their homes as all Duraclean Service is given on the premises of the customer. In the beginning they've used the family car as all equipment can be carried in the trunk. Their only investment has been a cash outlay of less than a $1000.

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Who are the customers? The finest homes in your community, yes. But, of equal importance hotels, motels, schools, shops, stores, offices, theaters, hospitals, and institutions. The commercial business is big and because much of this work can be done evenings or Saturdays, many men have started in spare time without giving up their jobs or pay checks. When they have seen from actual experience that Duraclean could pay them many times their former salaries, they have resigned the old job and become independent businessmen—with all the added respect and standing that a businessman has in his community.

If you've ever had a really strong desire to "some day own your own business" the Duraclean Franchise is well worth investigating. We have no salesmen to try to influence you. The entire Duraclean Opportunity is explained in detail in a 24-page book. This book will be mailed free to any man sincerely interested in a future of security and independence. Just your name and address is all that's needed. Send it today. After reading all the facts, if you decide to take the next step, you can write again and let us know.

We'll help you with financing, with training, with equipment, and with all our years of experience in showing other men how to make their dreams become realities. To investigate costs nothing and does not place you under the slightest obligation. Is this something you should do for yourself? Today?

President

DURACLEAN INTERNATIONAL
9-180 Duraclean Bldg. Deerfield, Ill. 60015

Ford Marsh, President, DURACLEAN INTERNATIONAL
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Please mail details of the Duraclean Franchise opportunity. I will read your 24 page book. Then if I am interested I'll let you know. It is understood that I am not under any obligation and that no salesman will call to influence my decision.

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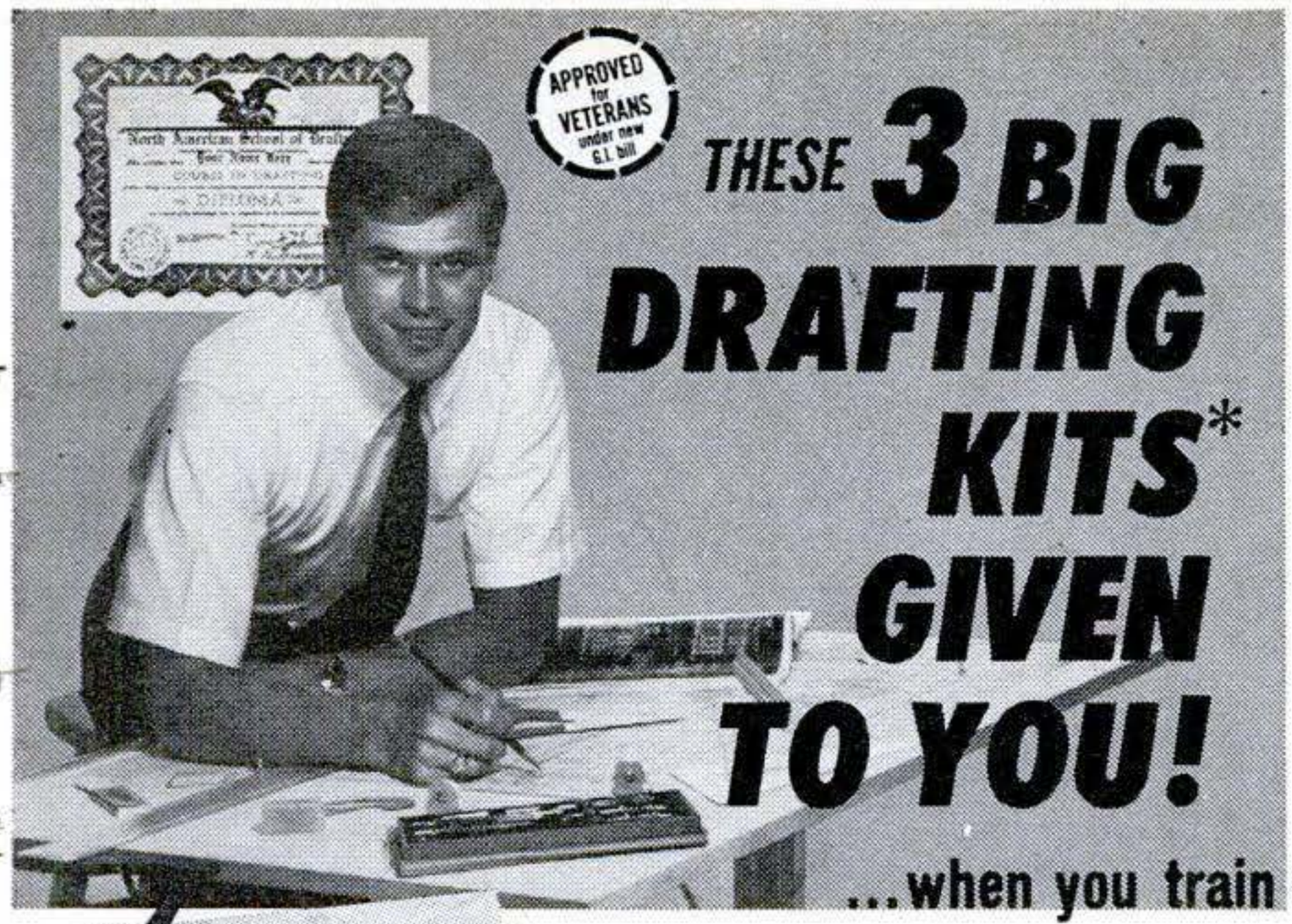

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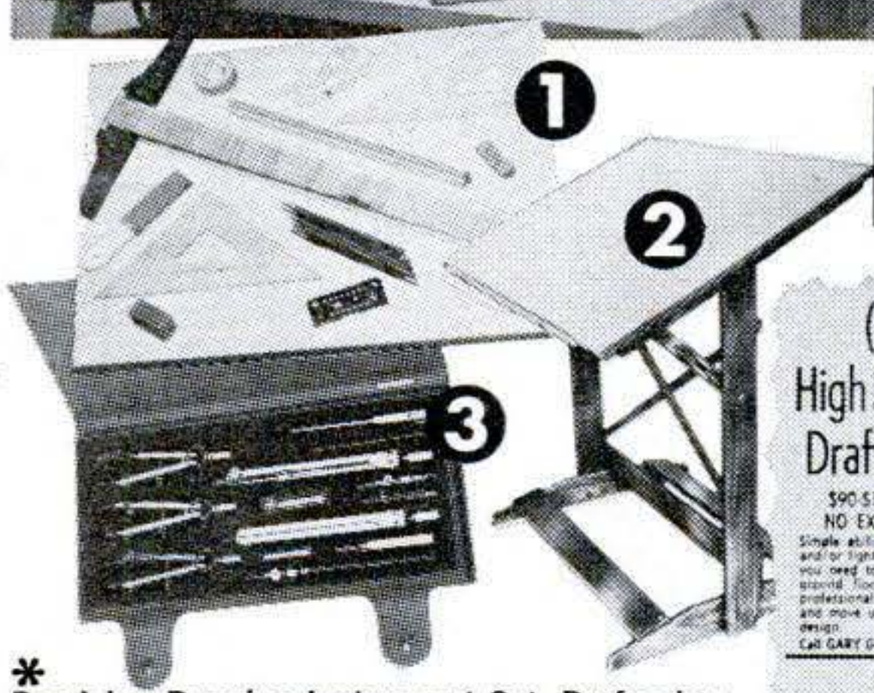

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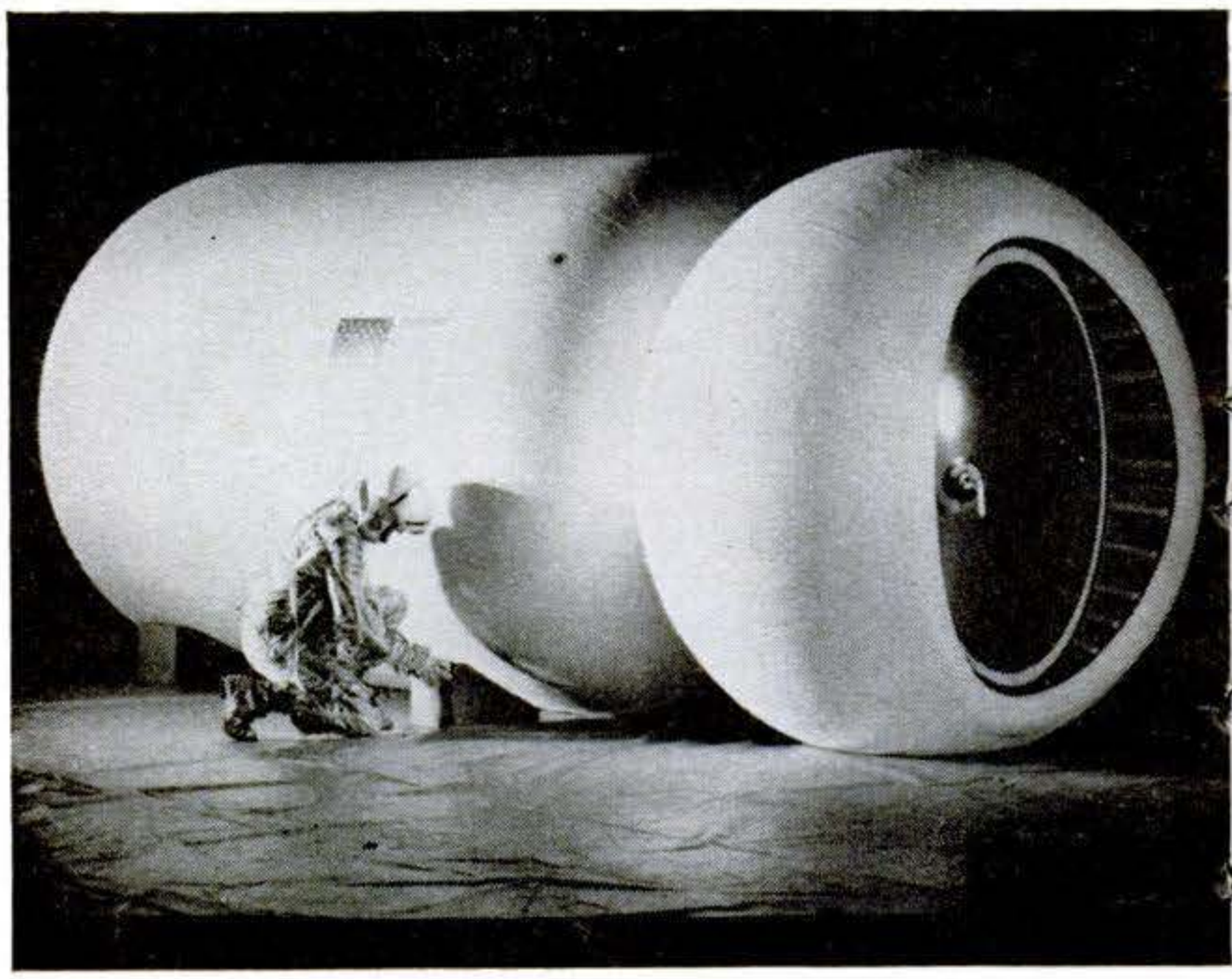
Science Newsfront

Last-minute news and notes to keep you up-to-date

By ARTHUR FISHER



First house on the moon may look like this model built by Goodyear for NASA. Skin of stainless steel filaments, other flexible materials, means that it can travel to moon stowed in a canister. There it would be inflated with oxygen to its full 13-foot length. The house could shelter two astronauts for eight days. Equipment inside would provide power, communications, shirtsleeve atmosphere, and all the comforts of "home."

A new technology based on magnetic "bubbles" and developed at Bell Telephone Laboratories may be as revolutionary a breakthrough for the information and communications industries as the invention of the transistor.

The bubbles are actually cylindrical magnetic domains—areas of local magnetization—about the diameter of a human hair. They are created when a magnetic field is applied to an orthoferrite—a magnetic material composed of rare-earth iron oxides. The bubbles can be manipulated at will through thin sheets of the orthoferrite with very little energy. Not only can they be made to interact in a controlled way, but their presence or absence in a circuit printed on the orthoferrite's surface can be detected. Thus they can be used to code information.

Within five years, Bell scientists predict, bubble devices may begin to replace electronic integrated circuits in switching systems and computers. Future possibility: a data-storage file holding 15 million bits of coded information in a few cubic inches, operating on a fraction of a watt. A present computer memory of this size would fill a hall and consume kilowatts.

Trapping waste materials in huge, collapsible rubber containers called pillow tanks may be one answer to some of the problems of water pollution. The idea, now undergoing federally funded tests in the Anacostia River in Washington, D.C., is to collect wastes in the tanks submerged in the river, rather than allow the wastes to flow directly into river water, as they do now. One system, using two 100,000-gallon tanks, temporarily stores storm sewer overflow caused by heavy rains until sewage treatment plants can accept it for processing. The project is being carried out jointly by the Goodyear Tire & Rubber Co. and Underwater Storage, Inc.

Solar neutrons could provide an early warning system for astronauts and crews of space stations. They would signal the immediate danger of lethal streams of high-energy protons from the sun.

Activity on the sun's surface ranges from quiet periods to furious outbursts characterized by great solar flares. During these times, the output of high-energy protons is particularly dangerous to spacemen.

But Dr. Stephen White, associate director of the Institute of Geophysics and Interplanetary Physics at the University of California, Riverside, believes that neutrons—also emitted by the sun—could warn of the protons' arrival. How? Neutrons travel in straight lines, because they are uncharged. High-energy protons travel in spirals. Therefore, the neutrons ejected from the sun at the beginning of a period of intense activity may arrive at the vicinity of the earth well before the protons.

Dr. White will check his theory by sending

Continued

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A typical Dodge "Job-Mated" van interior for general service, showing some of the equipment available to make your job easier. Choose the equipment to do your job right, from a wide selection of shelves, drawers, bins, baskets, and many others.

It all started with the hot-selling Dodge compact van. And now, its versatility has been extended to eighteen "Job-Mated" units like the one shown below, outfitted to handle the needs of just about any trade. And you can order your Dodge Tradesman Van with options such as air conditioning, power steering, or automatic transmission. Only Dodge offers power steering on compact vans. Proof again that Dodge Truck is first with the most.

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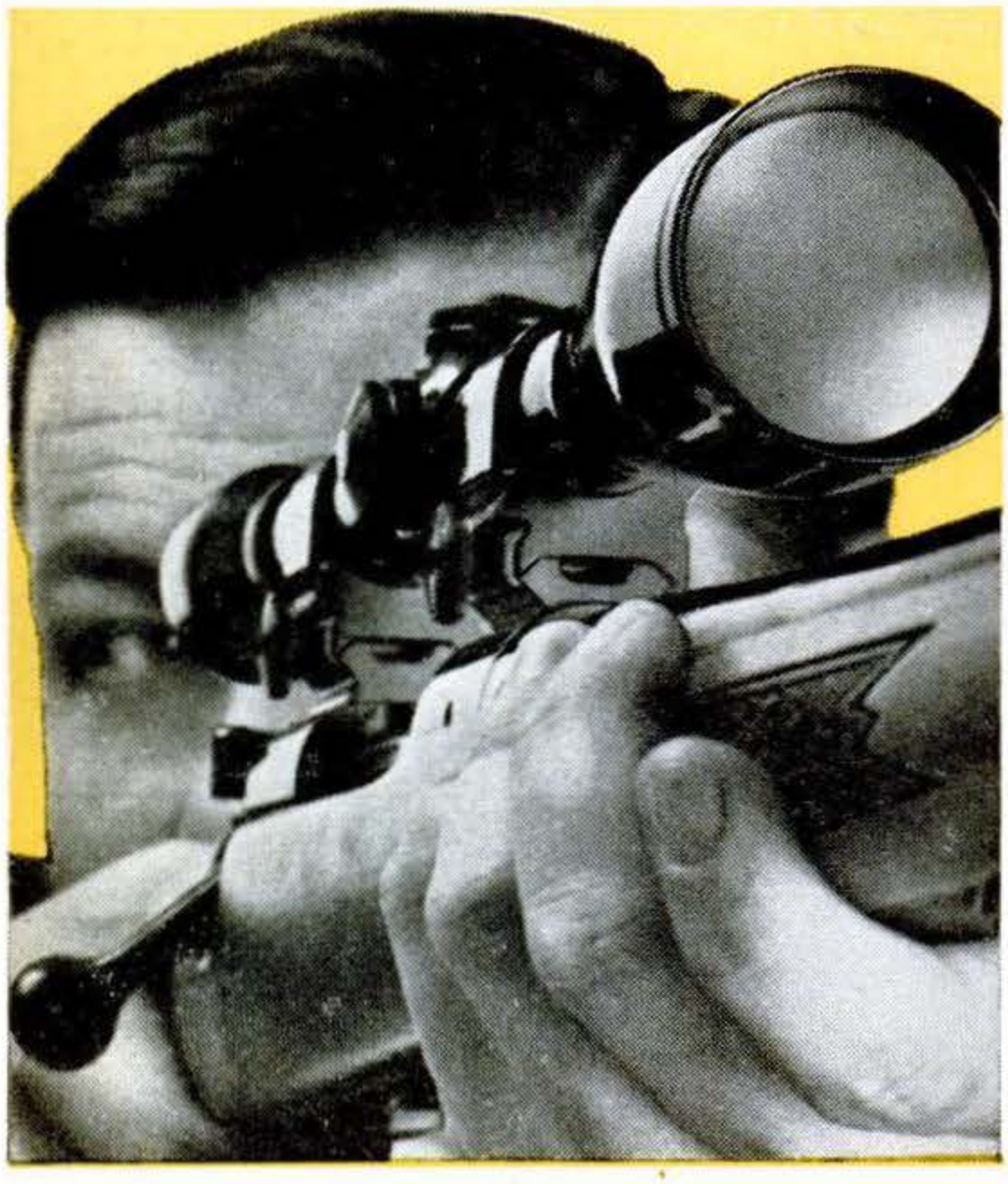

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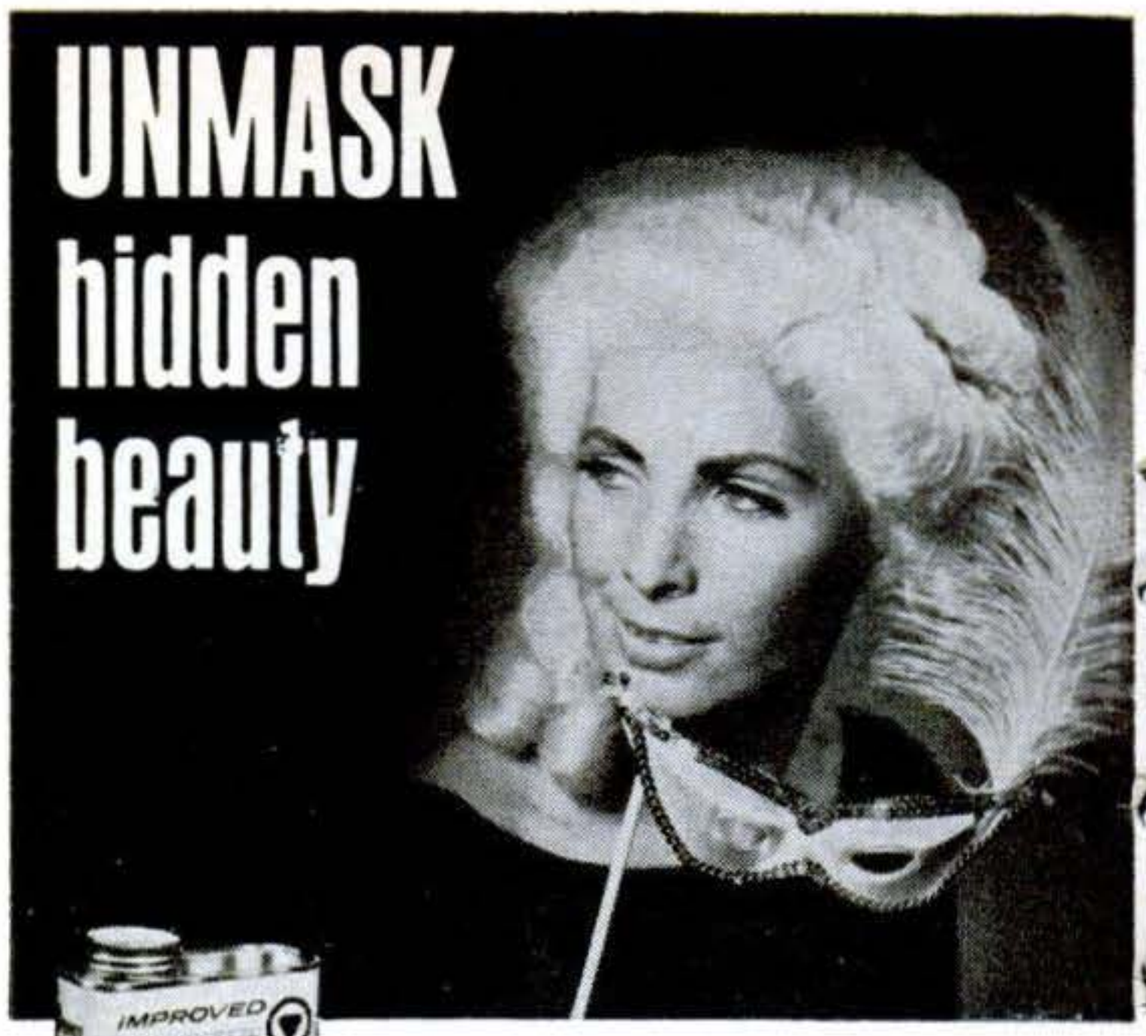

Costume masks, like old finishes, have a tendency to hide rather than enhance true beauty. Savogran's STRYPEEZE Semi-Paste paint remover will unmask the hidden beauty of natural wood, furniture or antique pieces that have been disguised under old paint or varnish.

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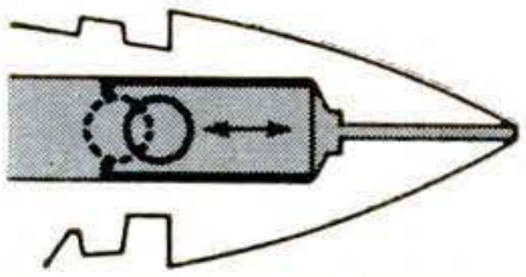

USM Corporation
Consumer Products Division
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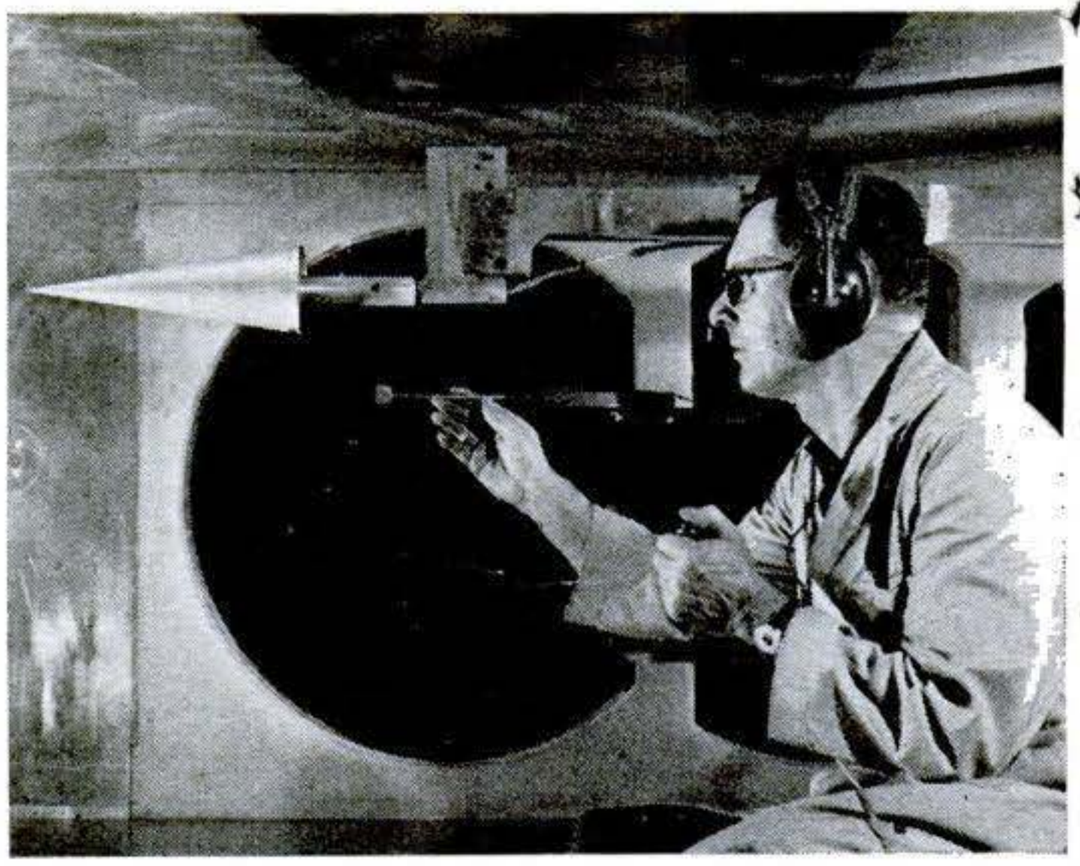
Science Newsfront

[*Continued*]

two scintillators 100,000 feet up in a helium balloon to measure neutron and proton activity, during solar flares and quiet periods.

Must the thunder of sonic booms be a permanent penalty we pay for supersonic flight? Aircraft designers, still pressing for a way to make haste silently, are now concentrating on how wing shapes modulate the damaging boom. In preliminary studies at the Air Force Systems Command's Arnold Engineering Development Center at Tullahoma, Tenn., engineers used a wind tunnel to test a triangular wing body. Leading edges with a variety of shapes could be interchanged. The ball below the wing in the picture is a pressure-sensitive probe that measures pressure patterns around the experimental wing shapes. These patterns reveal the sonic-boom pattern that each shape will produce.



"Hot spots" inside tires can be detected by tire manufacturers with a new testing system, called Spinvision, demonstrated by the Armstrong Rubber Tire Co. The tire is mounted on a wheel that spins it up to 80 m.p.h. under load. Special detectors scan a stabilized "heat picture" of the spinning tire, revealing spots where excess heat is being generated. Hot spots are caused by flaws in the tire that will eventually lead to failure.

An airborne navigation system that uses an atomic clock will help prevent midair collisions. The Air Force has ordered 12 of the devices, which are made by Frequency Electronics. The clocks, which tune to the vibrations of cesium atoms, will run 3,000 years without losing a second. They will form part of collision-avoidance systems, which calculate the distance between aircraft from time signals. The airborne clocks will keep time in fractions of a microsecond. PS

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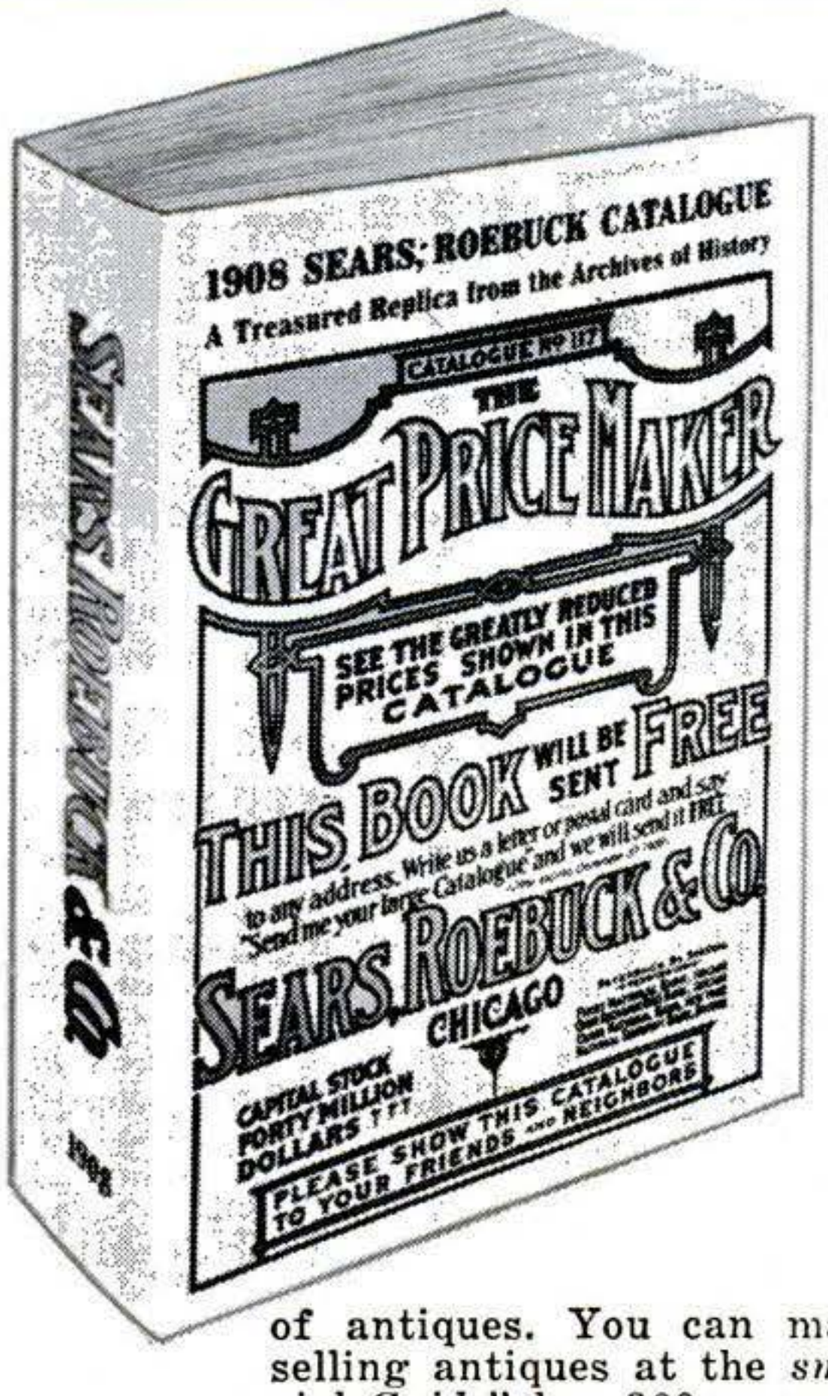

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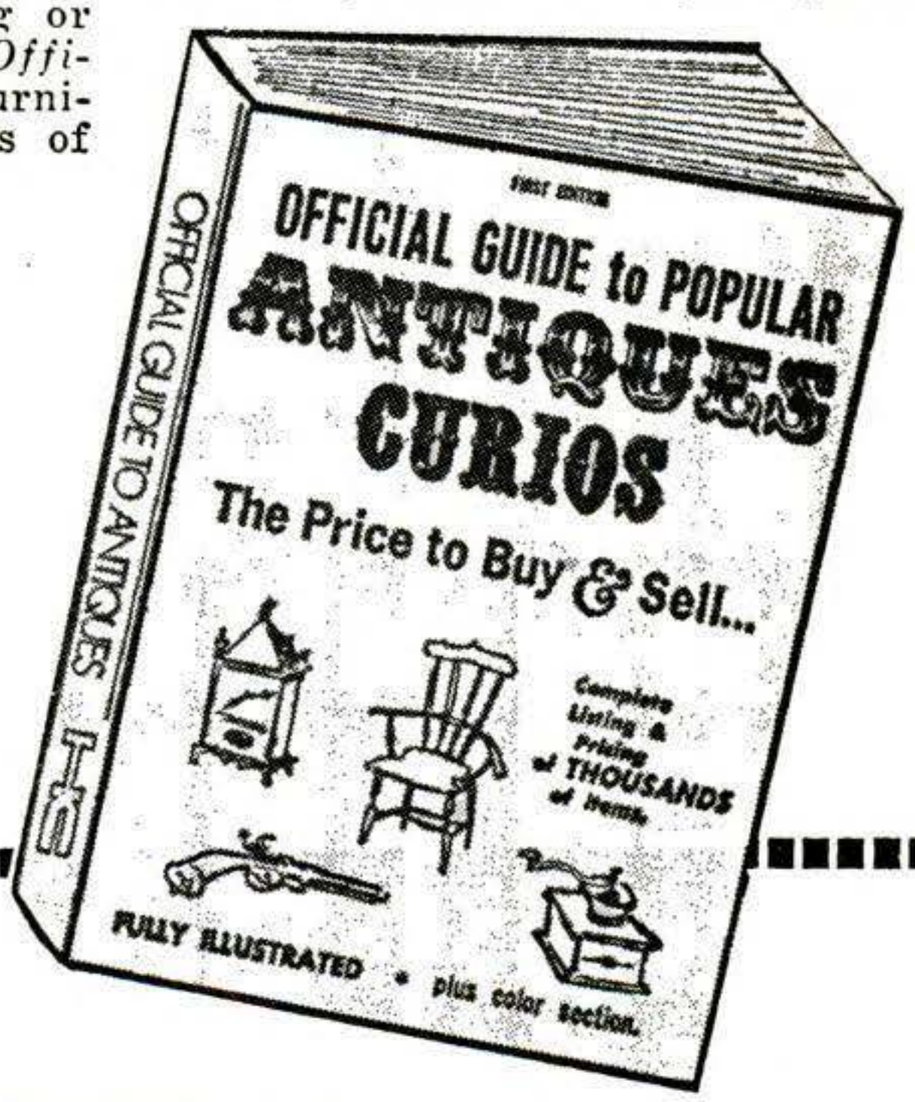

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Detroit Report...

CHEVROLET XP 887 TEST PROTOTYPES are now running round the clock at General Motors proving grounds in Michigan and Arizona. These test cars are cobbled-up Opels with widened track, but have the XP-887 running gear with a 140-cubic-inch single OHC four cylinder engine and three-speed automatic transmission. Biggest problem right now is high fuel consumption--12 to 15 miles per gallon, compared with 24 to 28 for the 115-cubic-inch four cylinder Opel, as used in the Kadett and the GT.

In a radical departure, the General Motors' XP887 engine will have an *all*-aluminum block. It will be die-cast without the usual cast-iron sleeves that have been a major block to the economical production of aluminum engines up to now. GM will use Reynolds 390 aluminum, an alloy with a high-silicon content, well-suited for die casting, and giving good cylinder-wall hardness. The new engines will be built at Chevrolet's Massena, N.Y., foundry, which was turning out Corvair engines until early this year. GM used a novel (in reverse) test arrangement: Engines were cast iron, but had aluminum sleeves inserted. Thus many aluminum alloys could be tested without casting an engine of each different metal.

A pneumatic bumper that will absorb 12- to 15-m.p.h. front-end crashes without damage to the body of the car is under test by GM. In the new design, the bumper extends about eight inches forward of the front sheet metal, and looks just like the one you see on present cars. In a crash, the bumper can be pushed back those eight inches without crumpling the sheet metal—something like a cat sheathing its claws. To absorb the shock of impact, the bumper is mounted on air-filled springs similar to the big rubber springs that are used on semitrucks and trailers. The new design weighs slightly more than present bumpers. Considering that it is under development by GM's Inland Division right now, it stands an excellent chance of being put into a production car within the next three years.

Air spoilers really work—if you go fast enough. I'm talking about the raised spoilers you see on the muscle cars like the Judge, Eliminator, Boss 302, Javelin, and the like. At 100 m.p.h., the spoiler on Pontiac's Judge presses down like a 70-pound weight on the rear wheels, improving traction and stability. Pontiac's chief engineer, Steve Malone, says it even helps at legal speeds, though not much. Air spoilers are more for *show* than for *go*, and are put on the cars largely for their styling appeal.

Company profits have a strong effect on the kind of car you drive. Two examples—one good, one bad: 1) Chrysler thinks that the huge amounts of money paid out in warranty claims will improve its profit picture if kept in the company. So, they're making individual plants responsible for warranty claims on their products, something not done in the past. Now the responsibility for quality cars will go right back to the factory that goofed, and you can bet quality will improve. 2) GM is planning to cut costs by building one front-suspension design for each size of its cars. Could be in effect within two years. That means differences between GM car lines will be fewer in the future, and there will be less chance for the buyer to make a choice between really different products.

A knock-down, drag-out battle is shaping up in the small-car market, triggered by the Maverick. The Ford sub-compact is outpacing Mustang sales and is giving Ford a big jump on the competition. If the trend continues, American Motors' Hornet will also reap a great harvest of buyers. While Chevrolet and Plymouth offer low-price versions of Novas and Valiants to sell against the successful sub-compacts, they may not be able to compete in this market for long. Due to continued inflation and tight money, the small cars are finding a growing number of customers. The coming year will see a new battle between the major companies, when the GM, Ford, and American Motors mini-compacts go into production.

Jim Dunne

Detroit Editor

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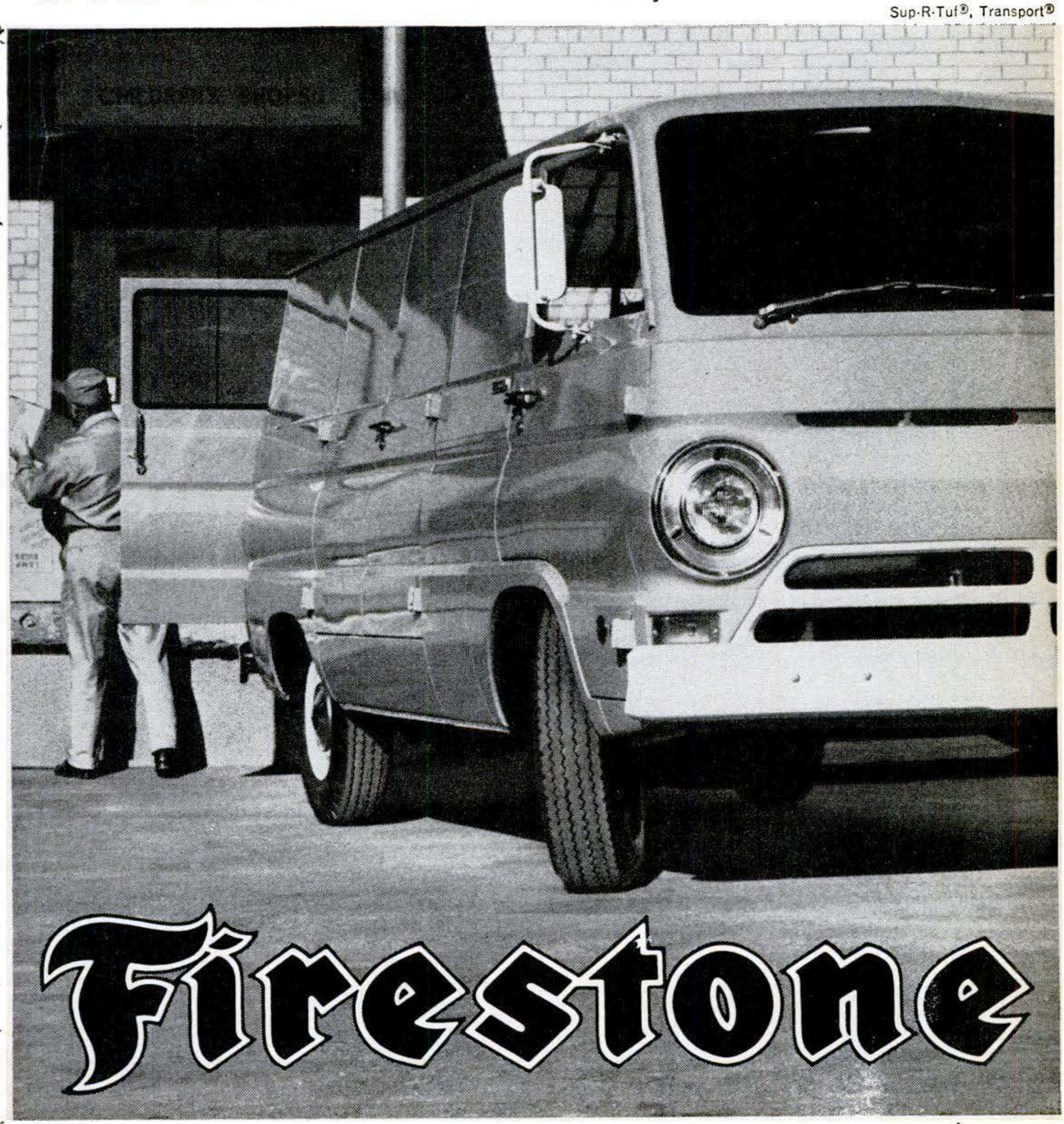

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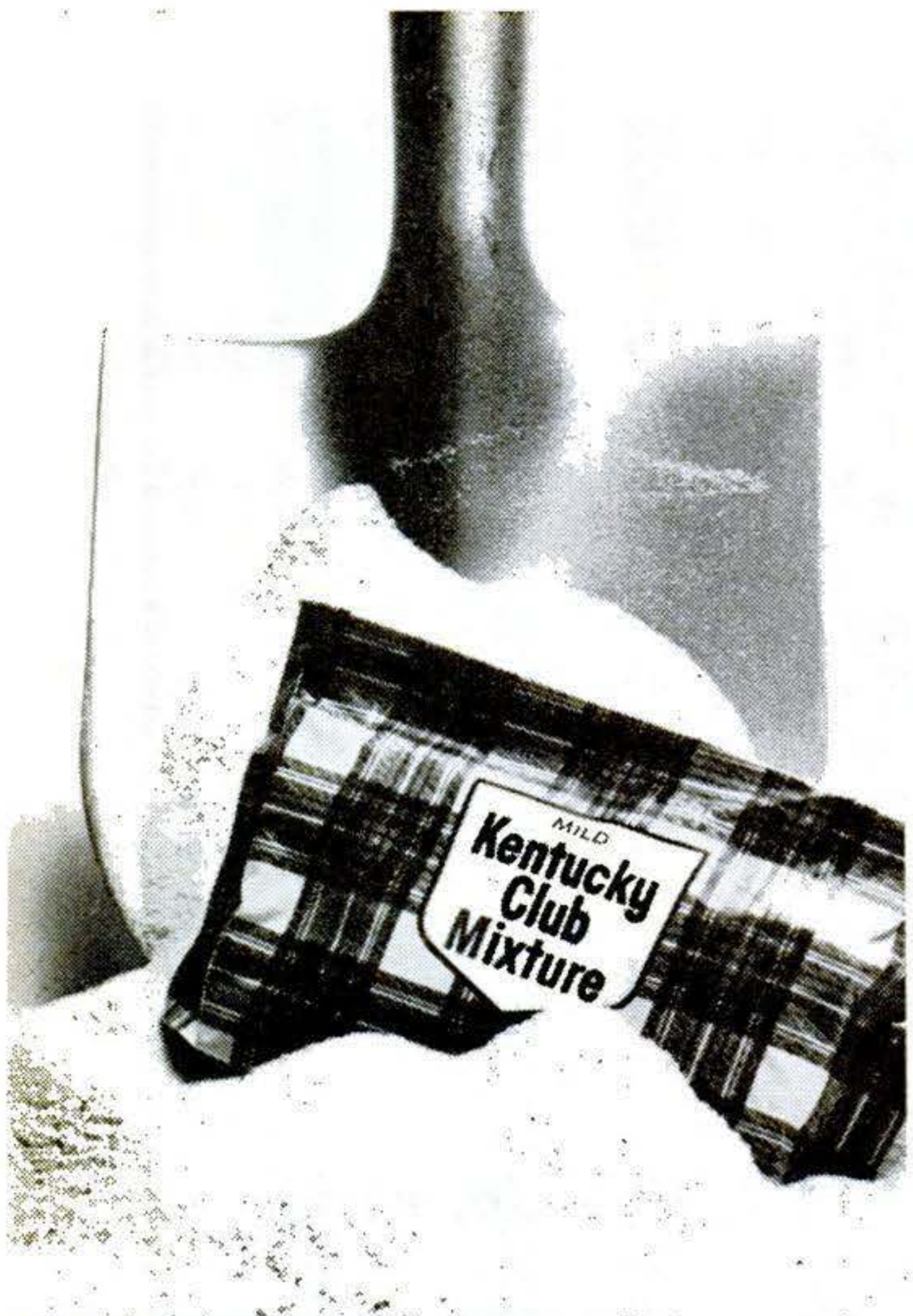

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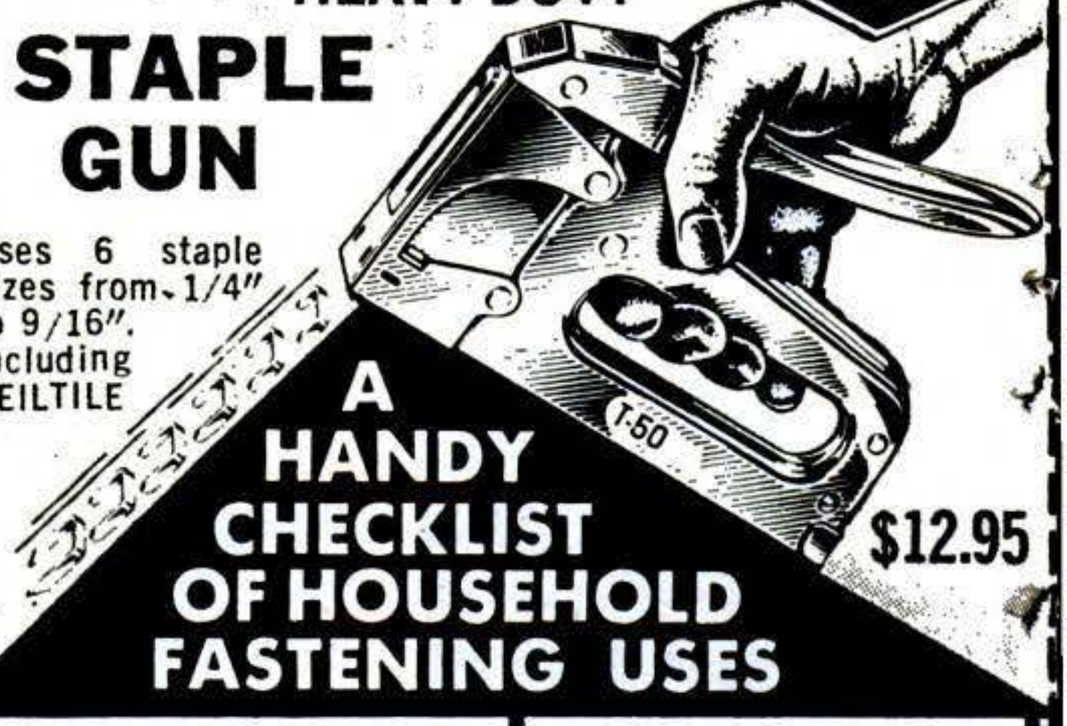

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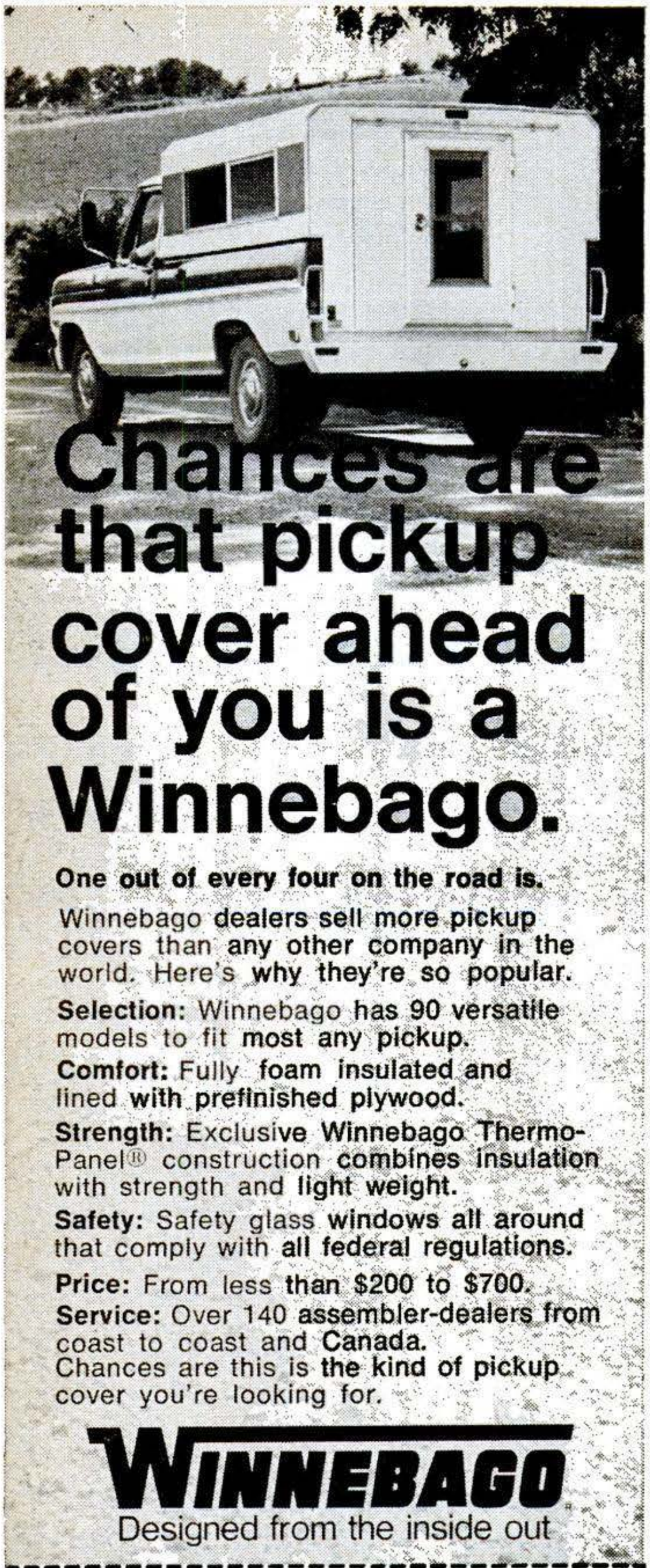

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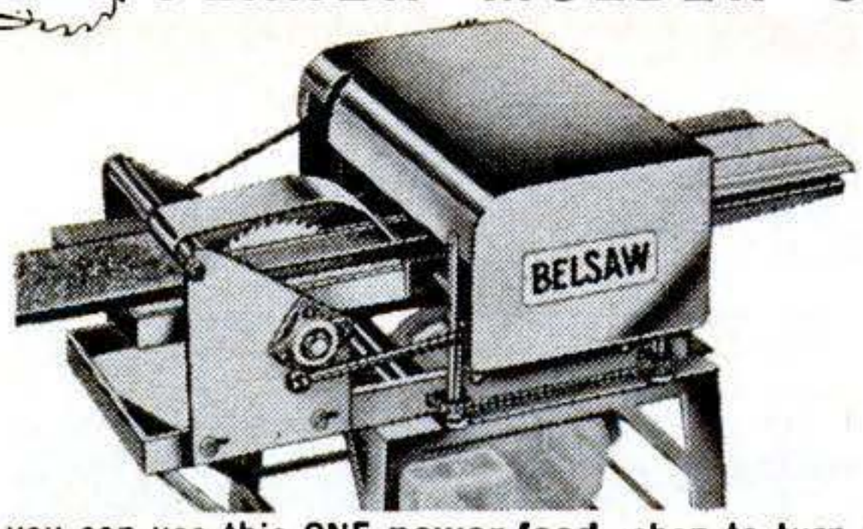

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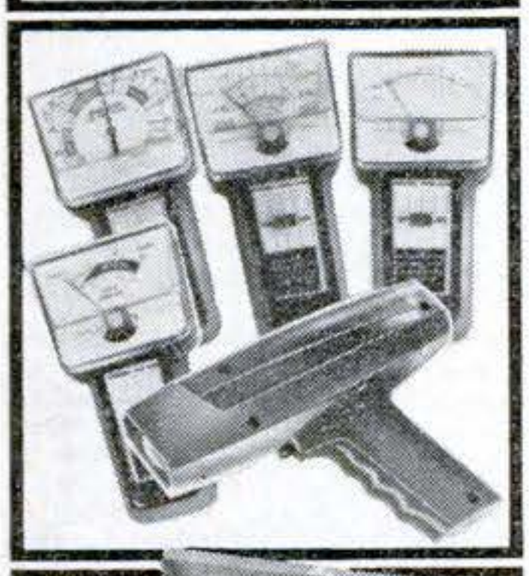

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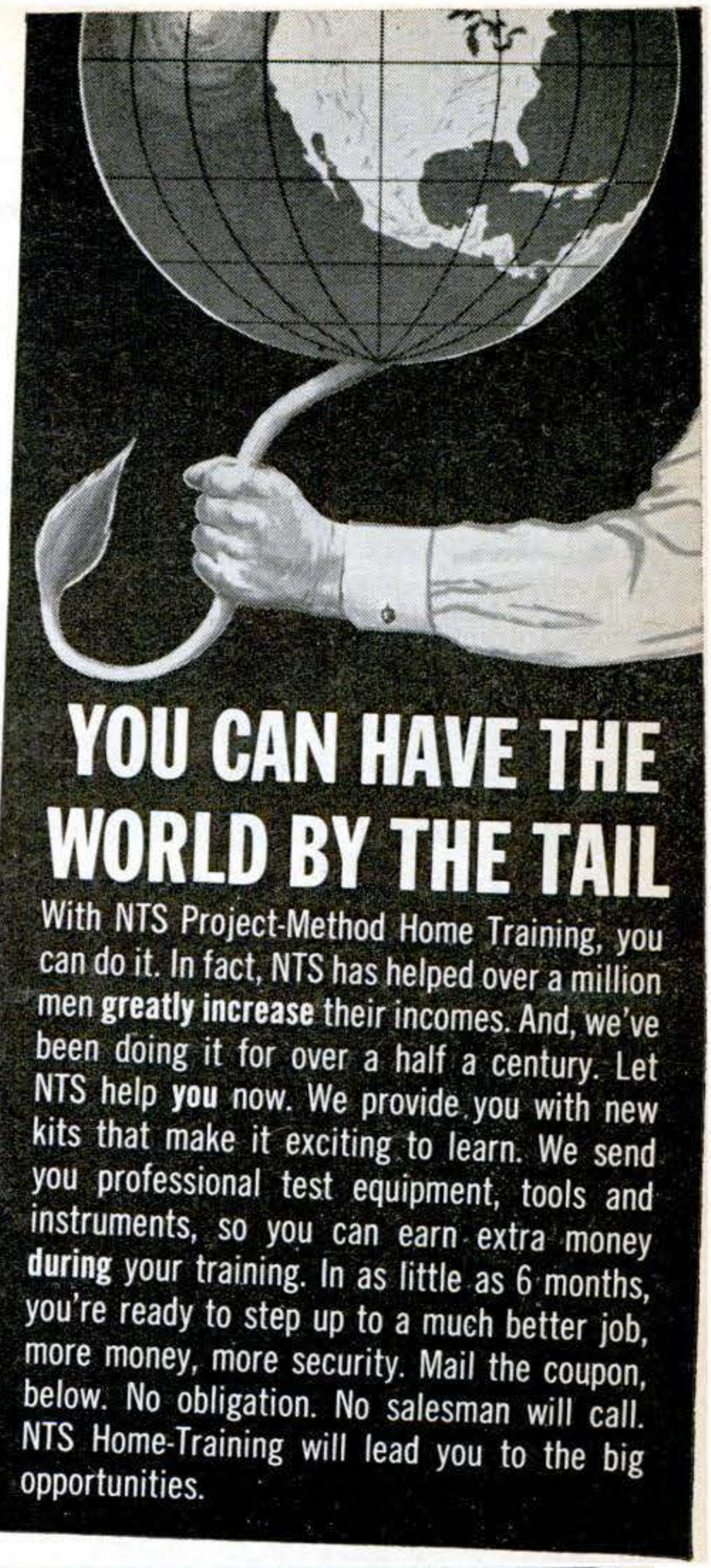

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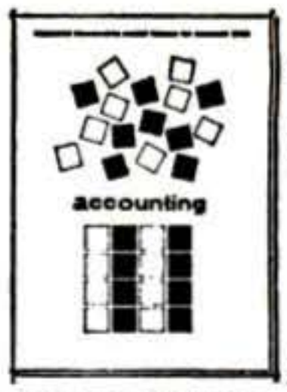

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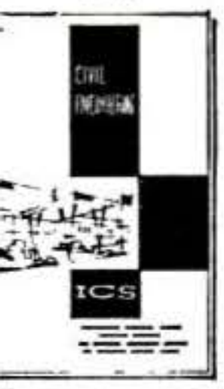

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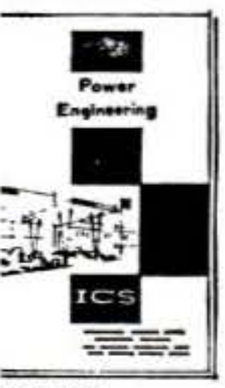

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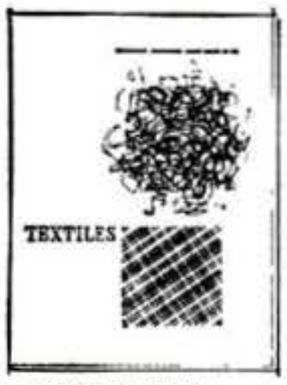

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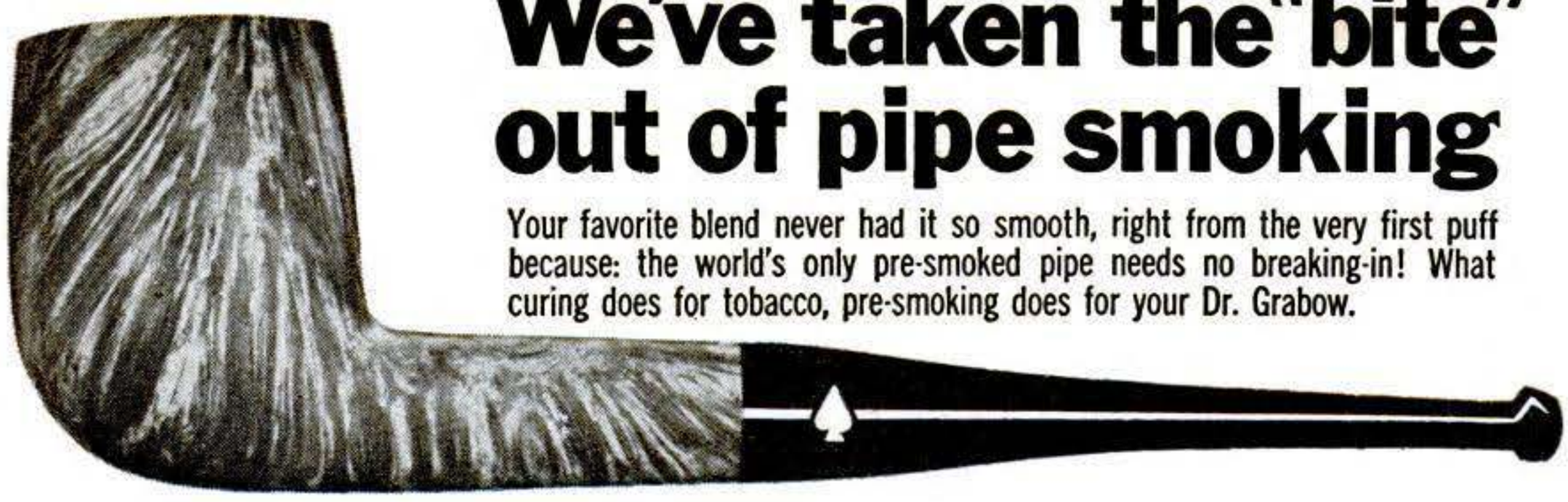

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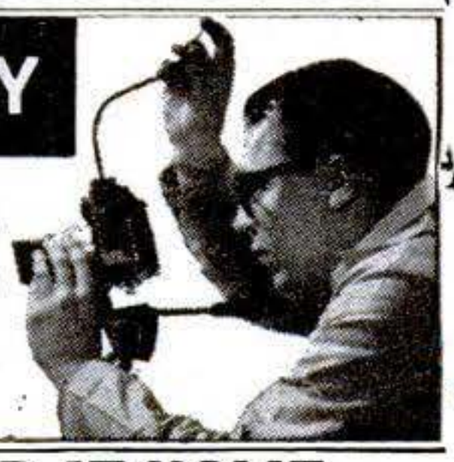

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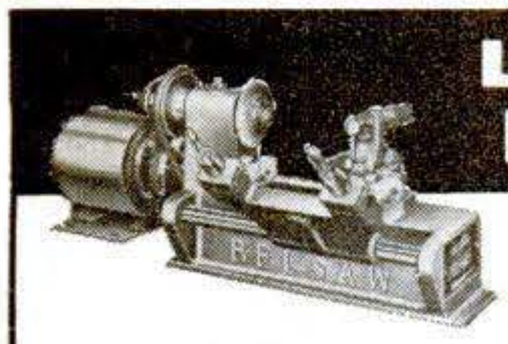

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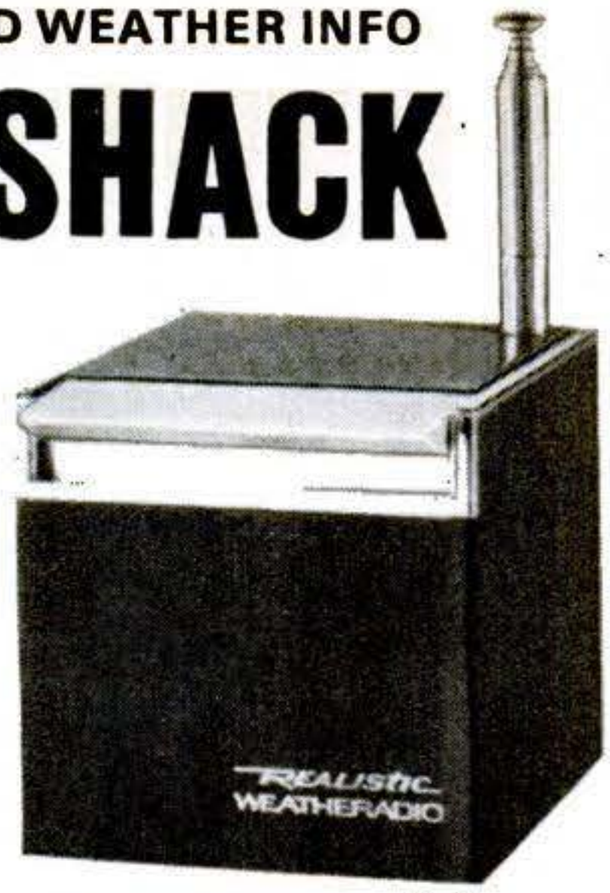

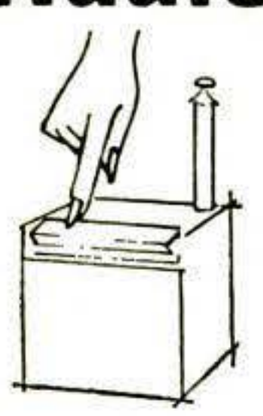

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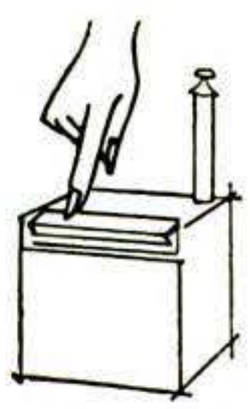

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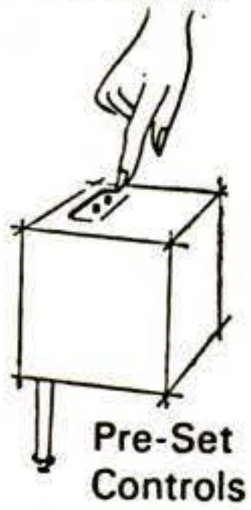

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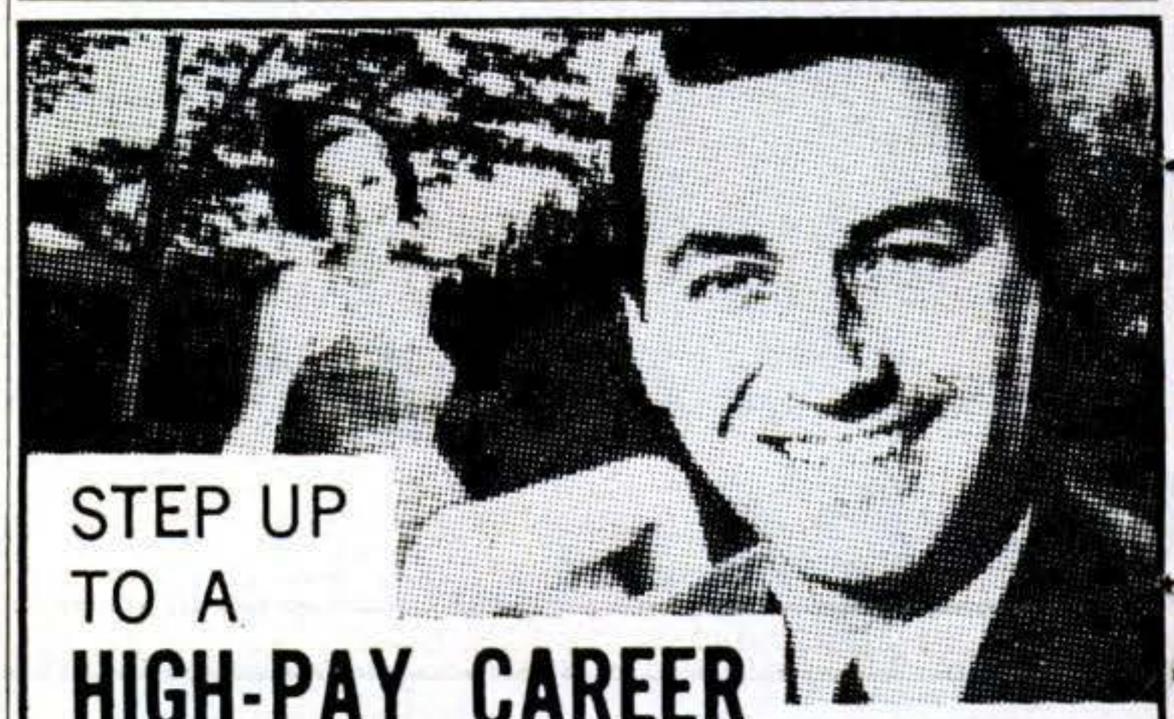

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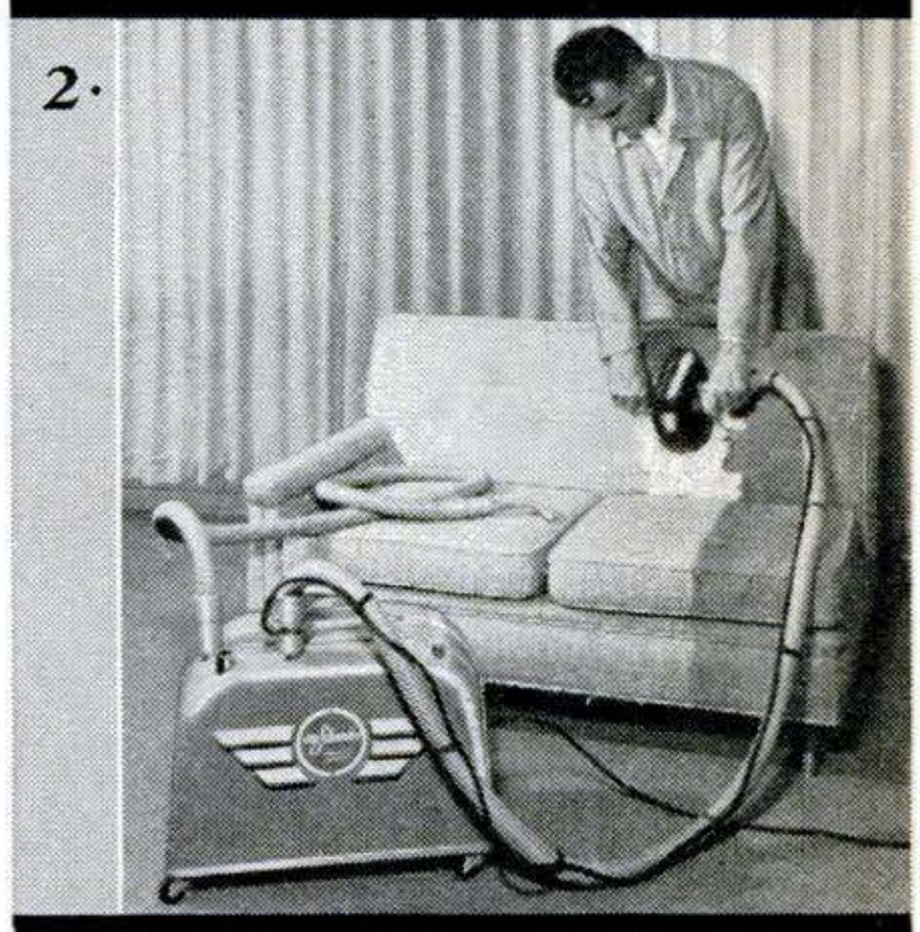

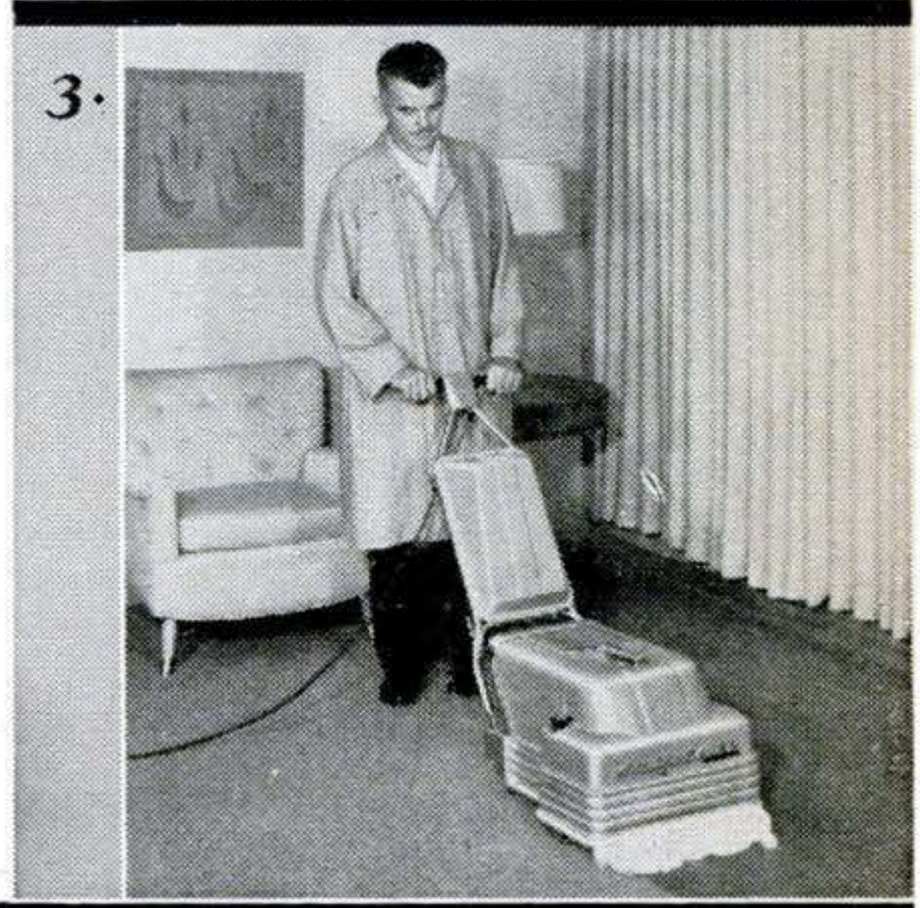

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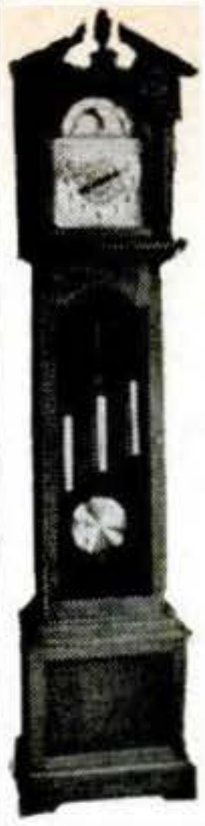

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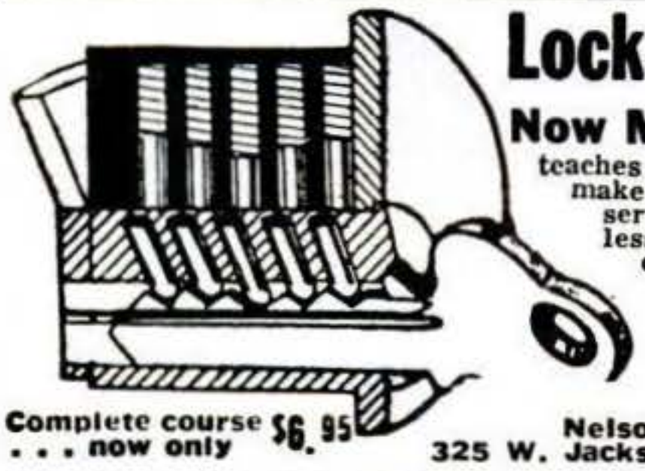

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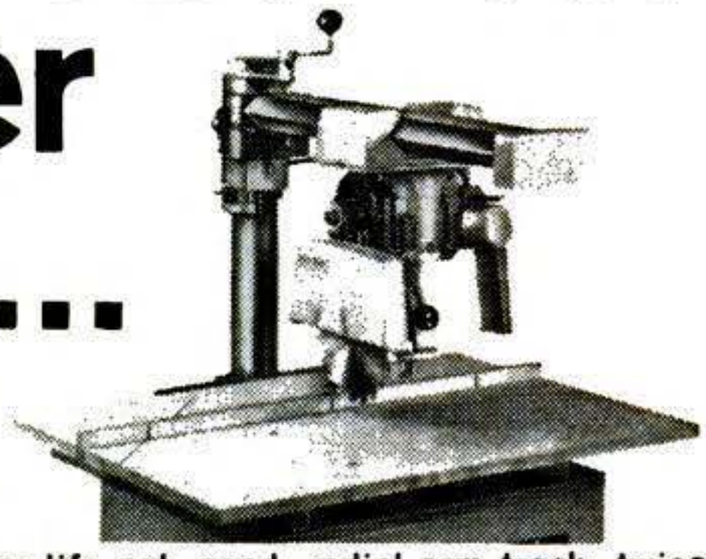

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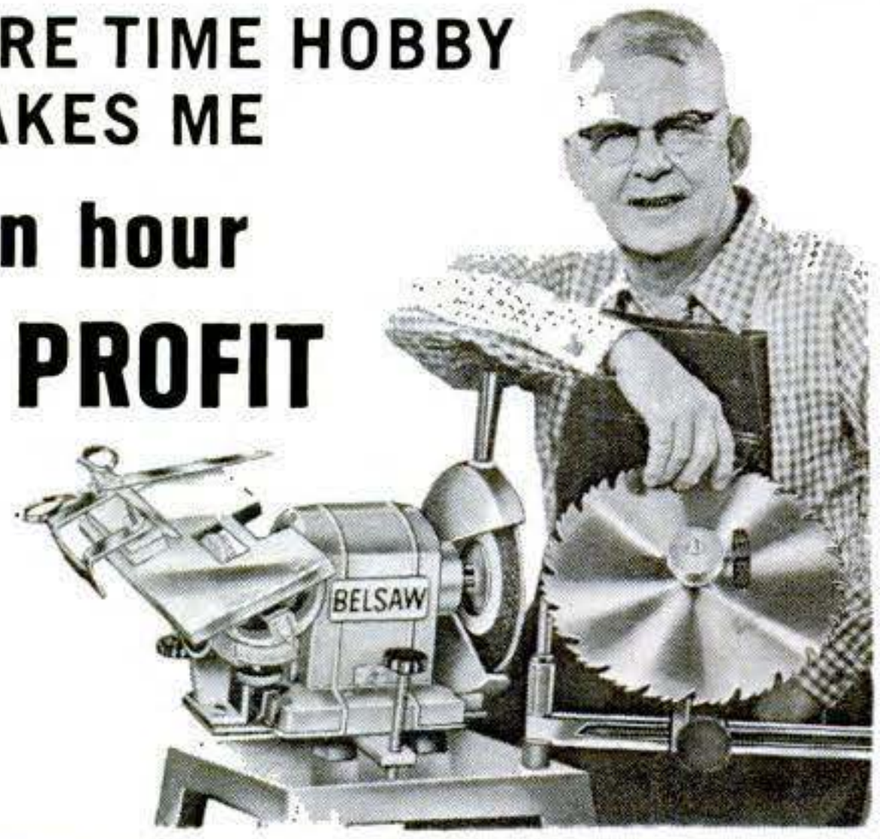

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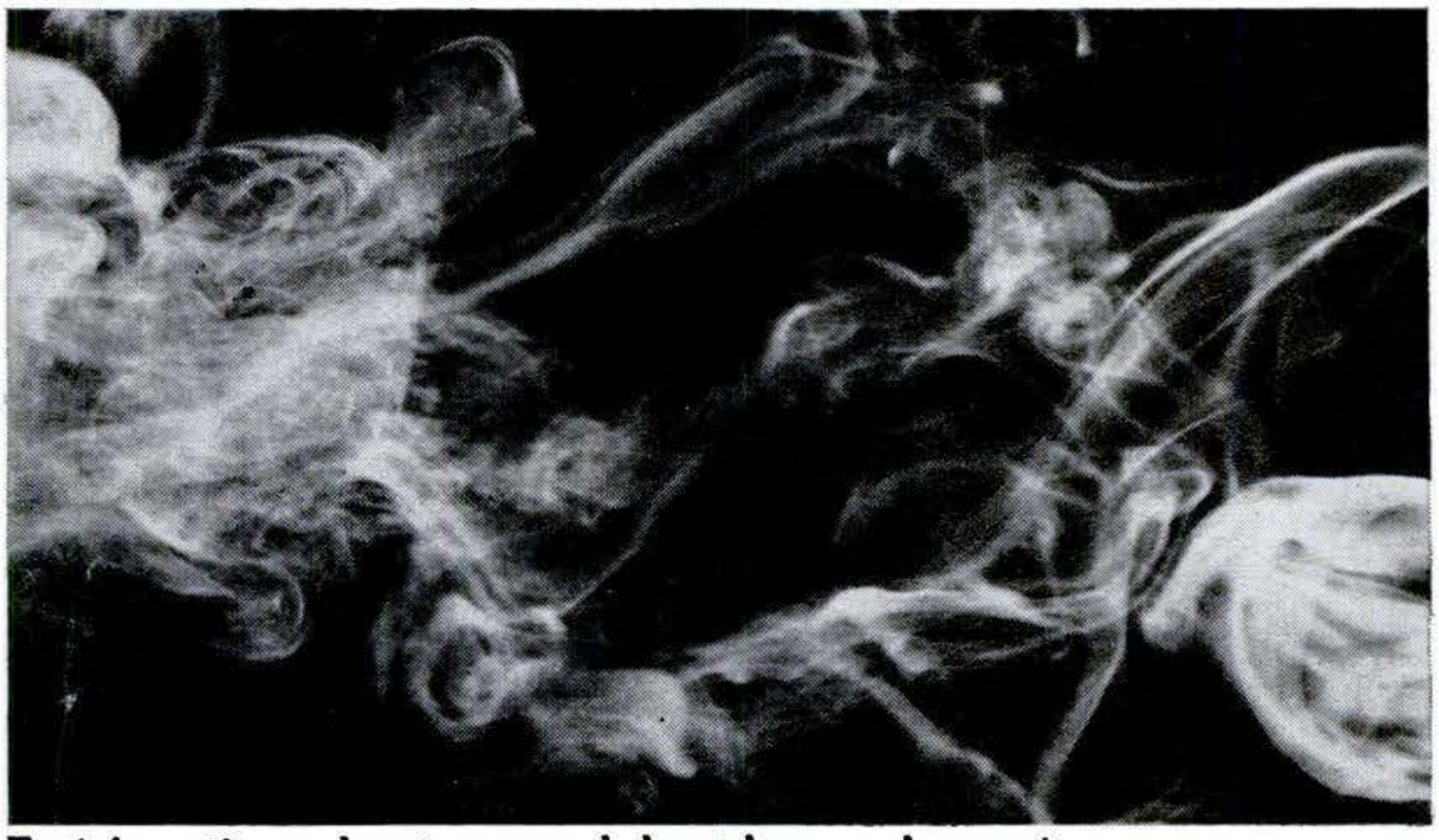

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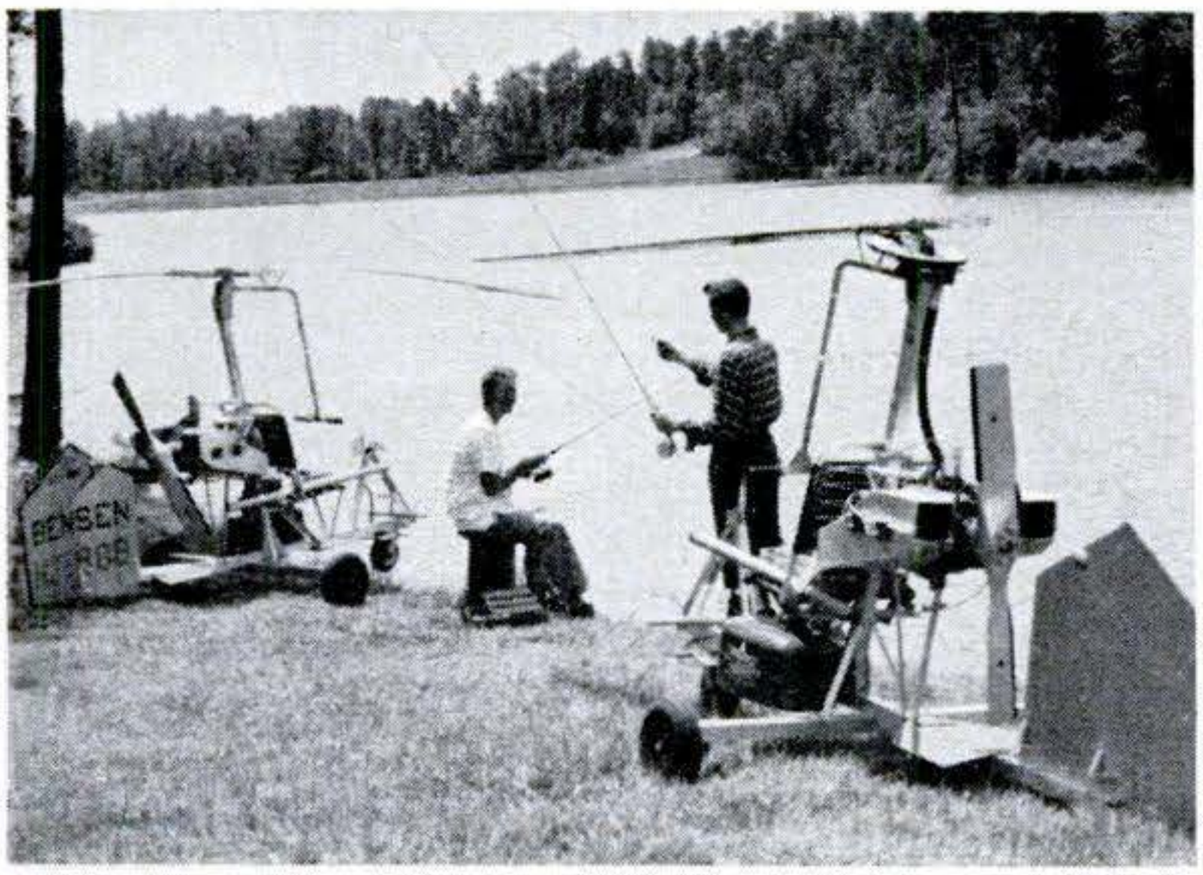

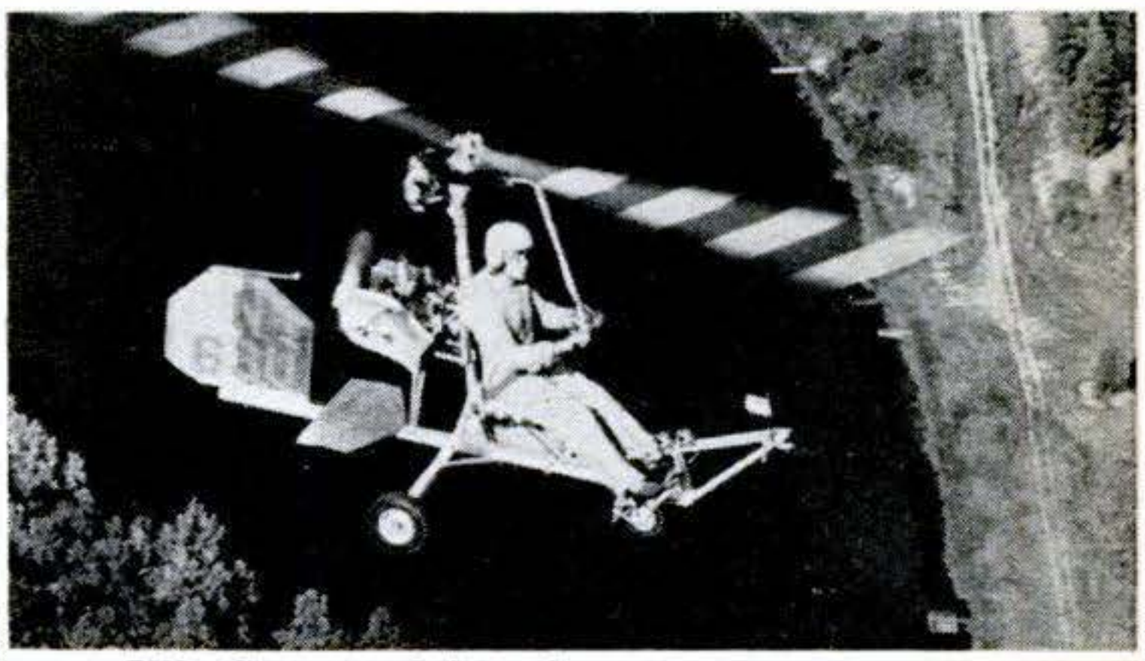

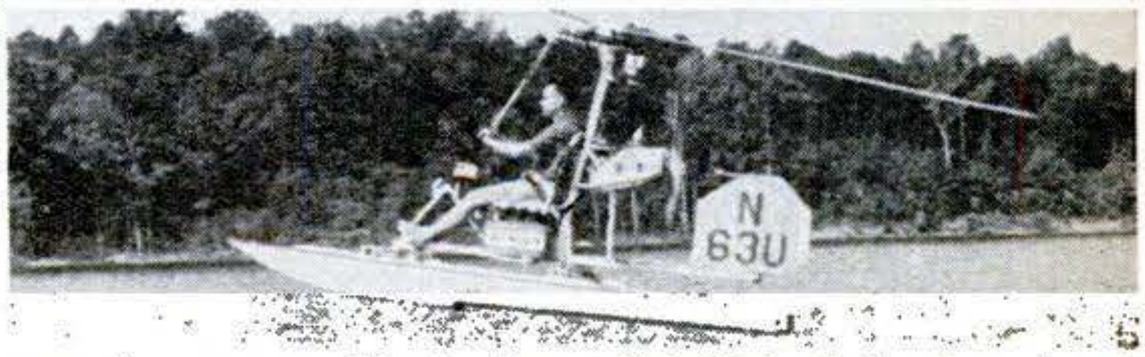

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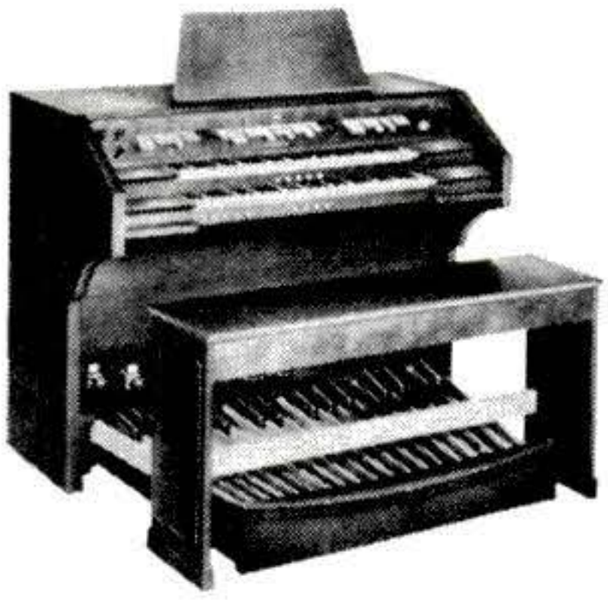

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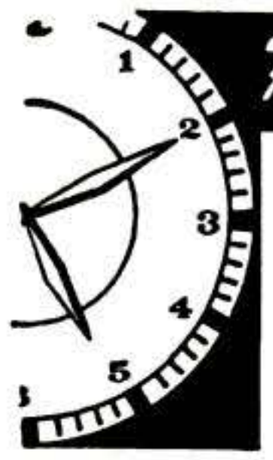

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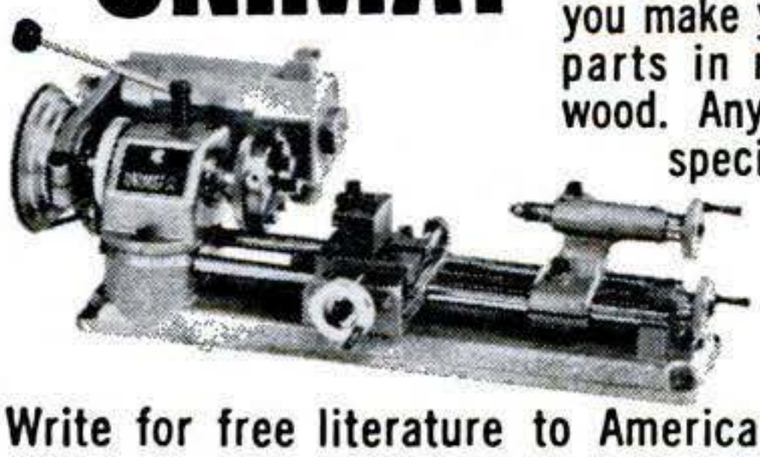

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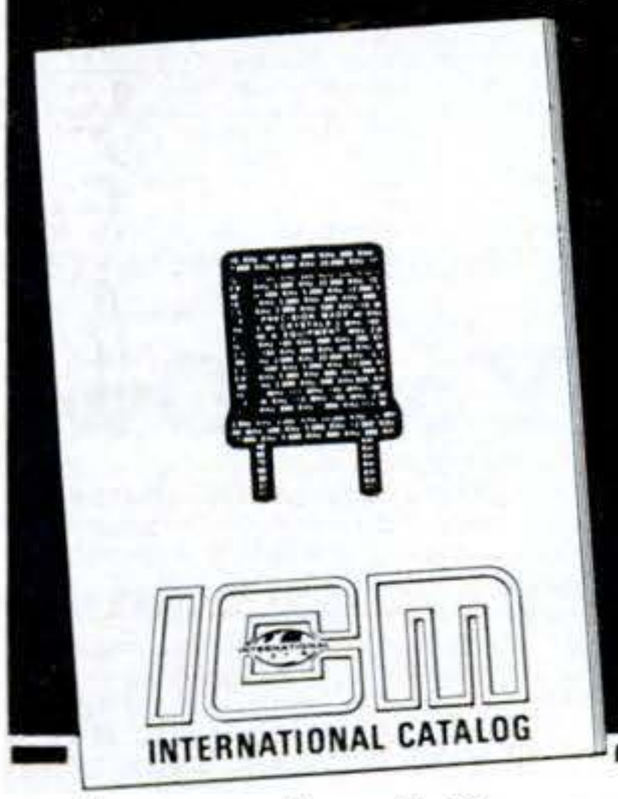

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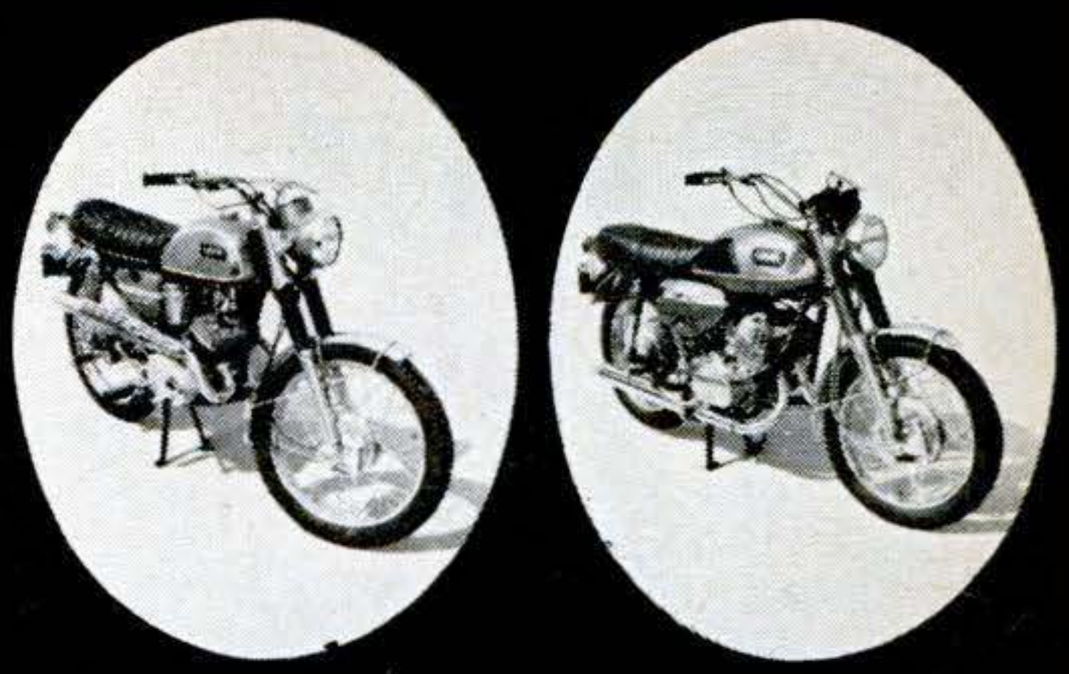

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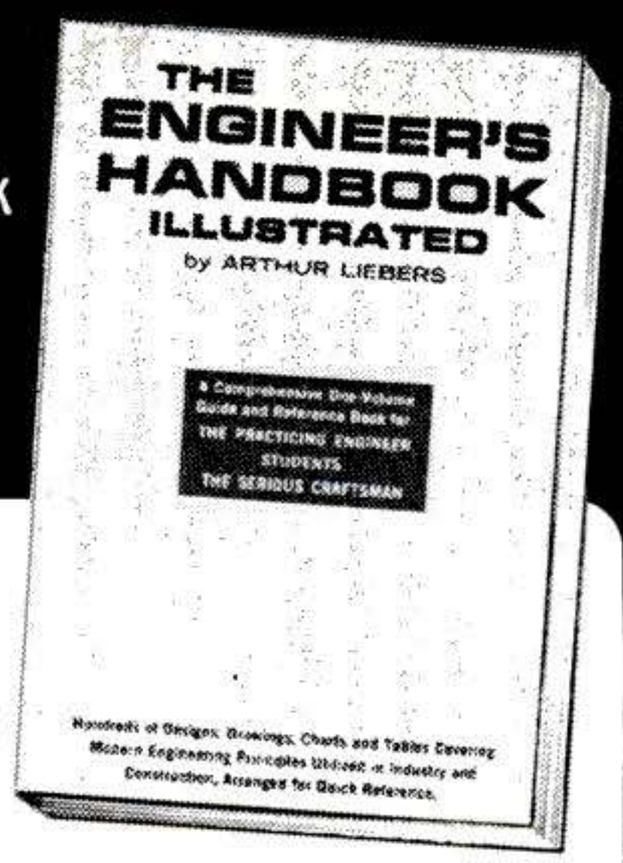

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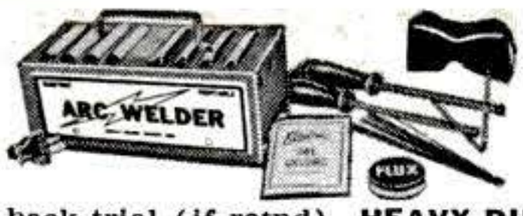

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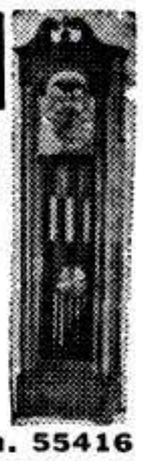

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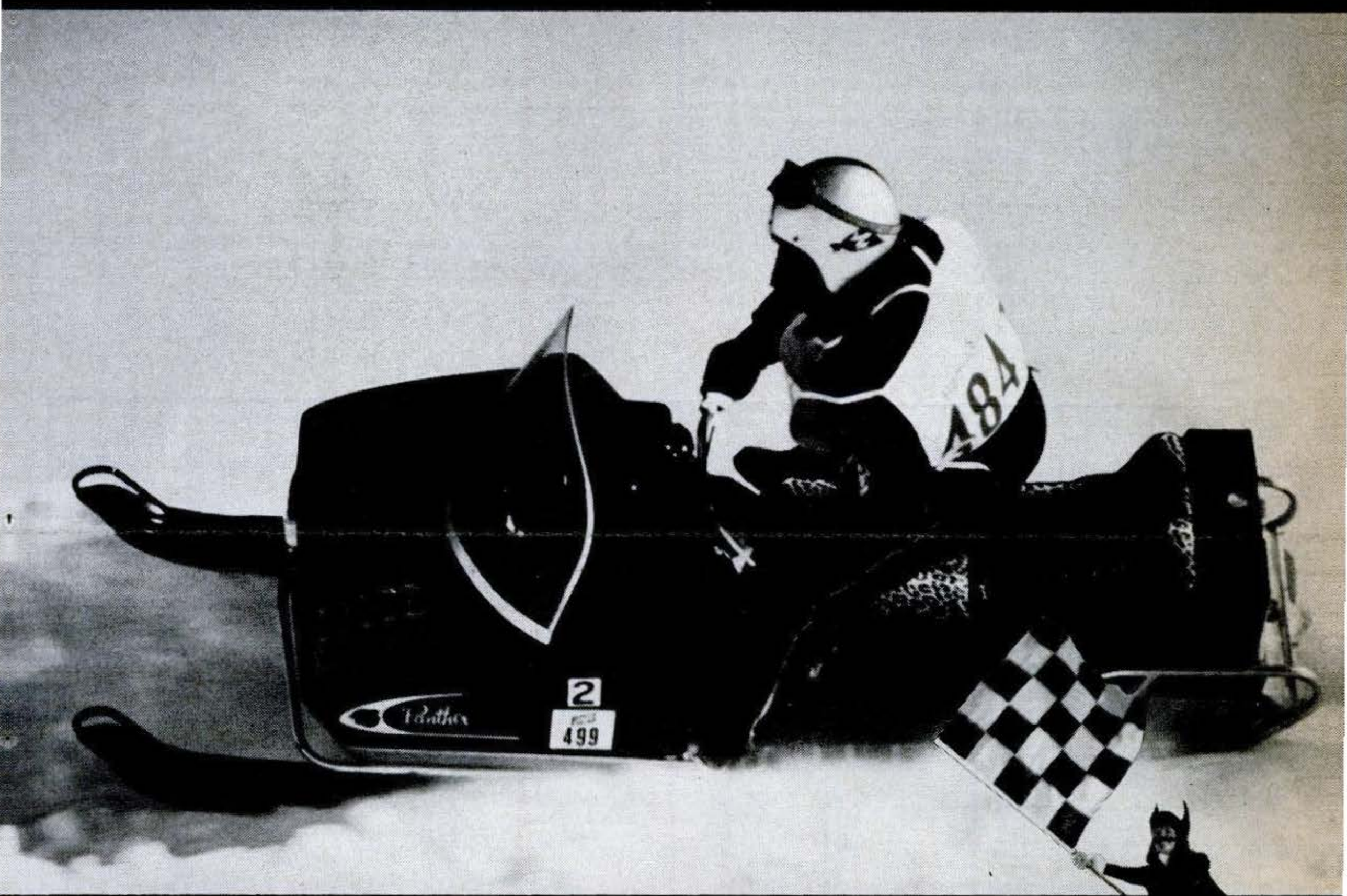

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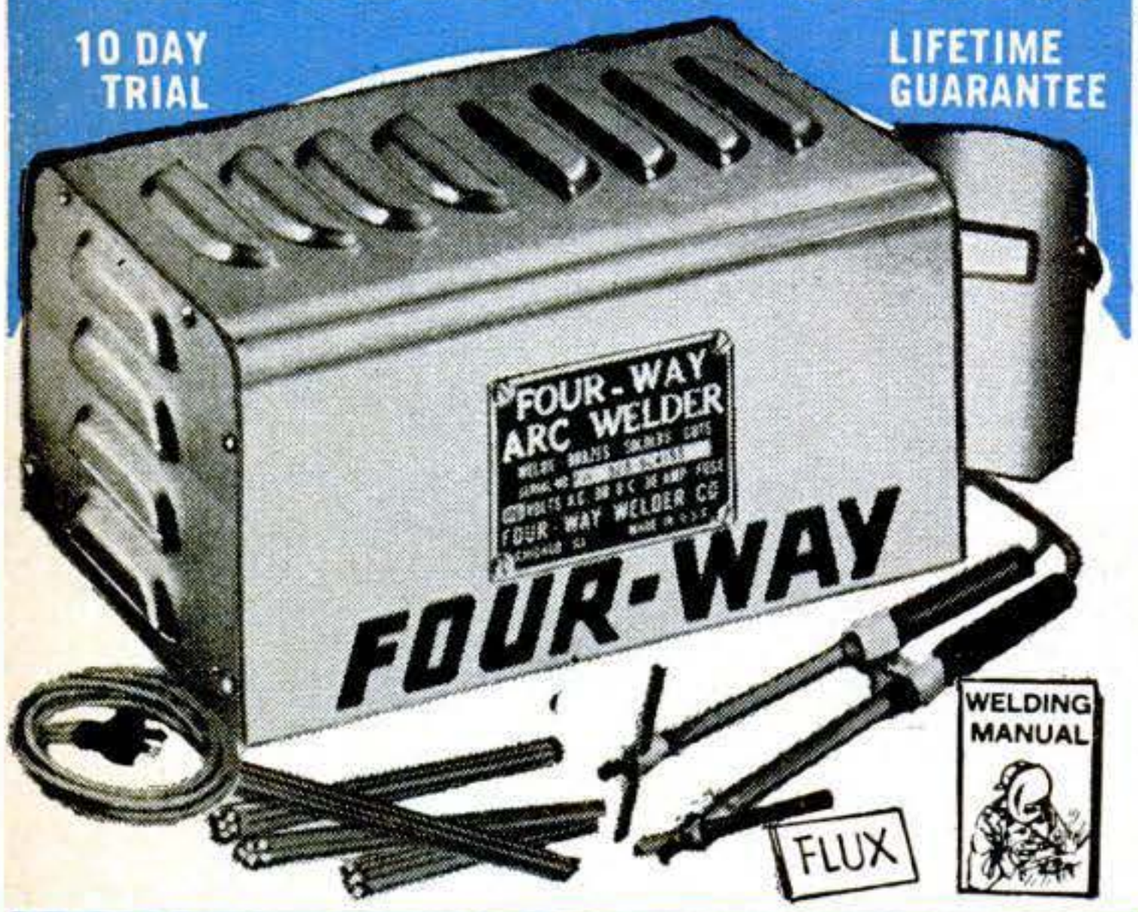

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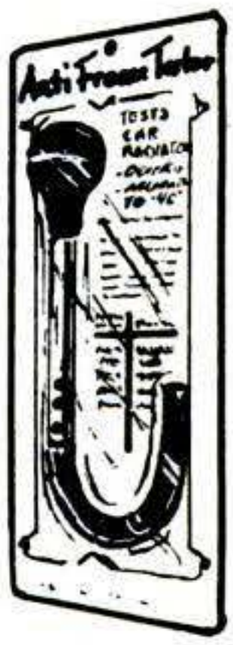

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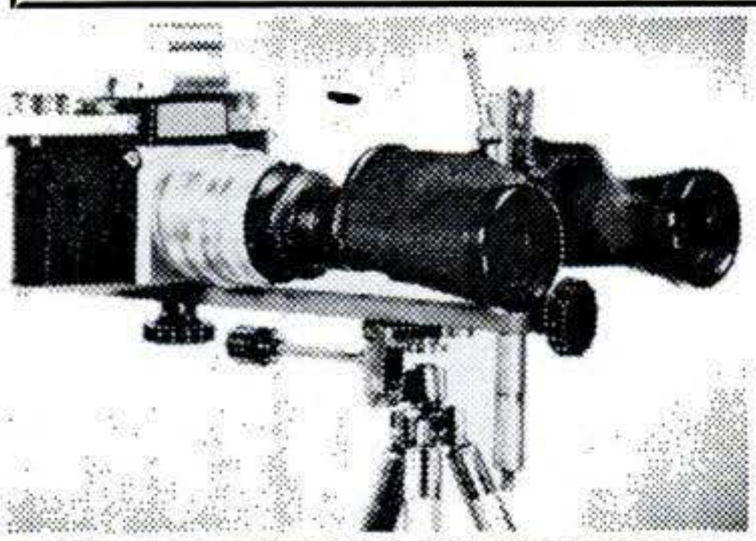

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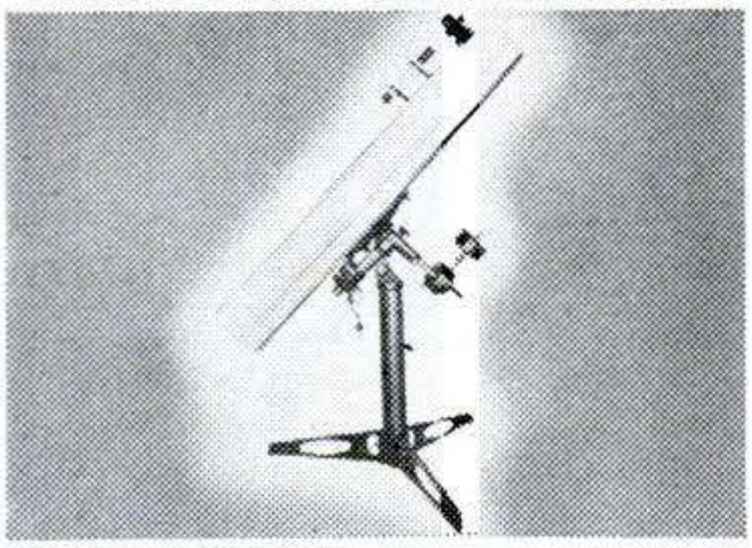

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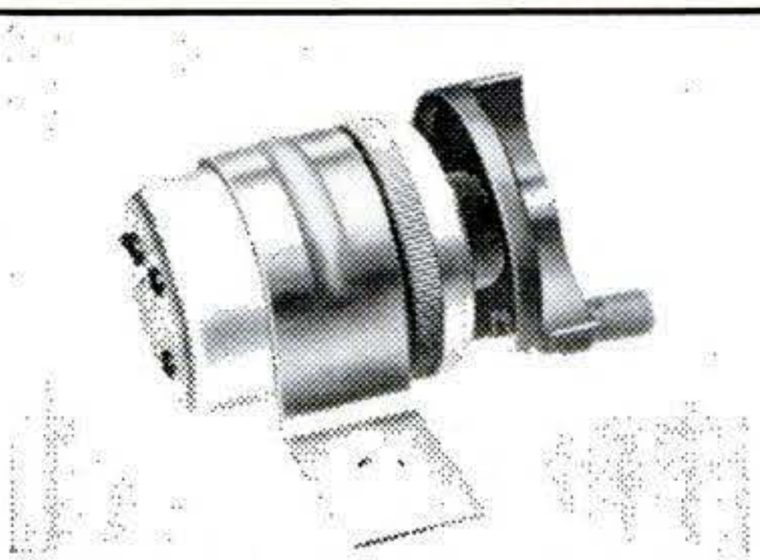

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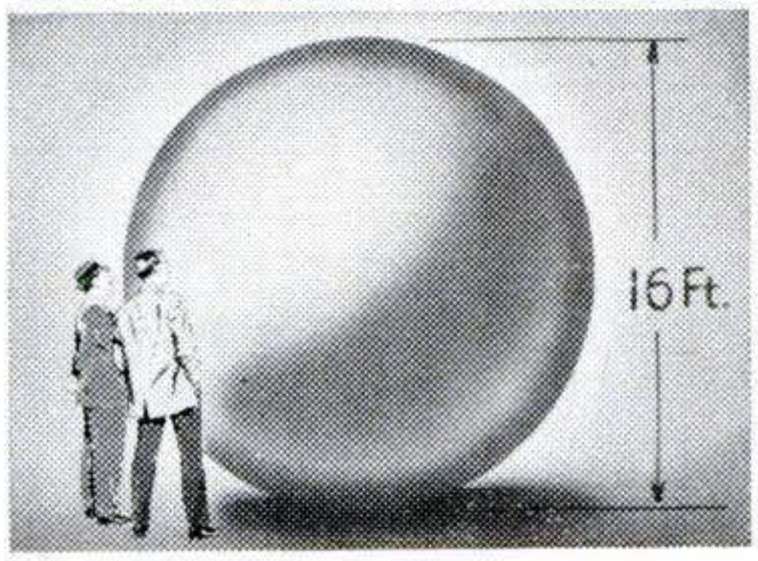

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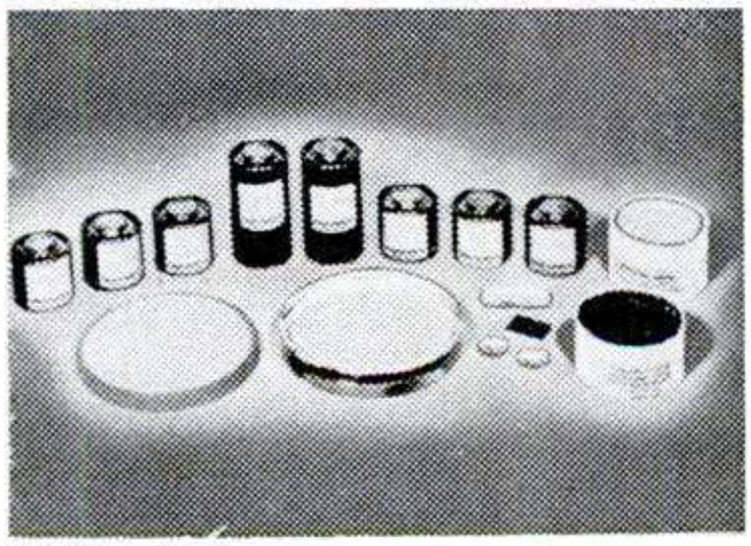

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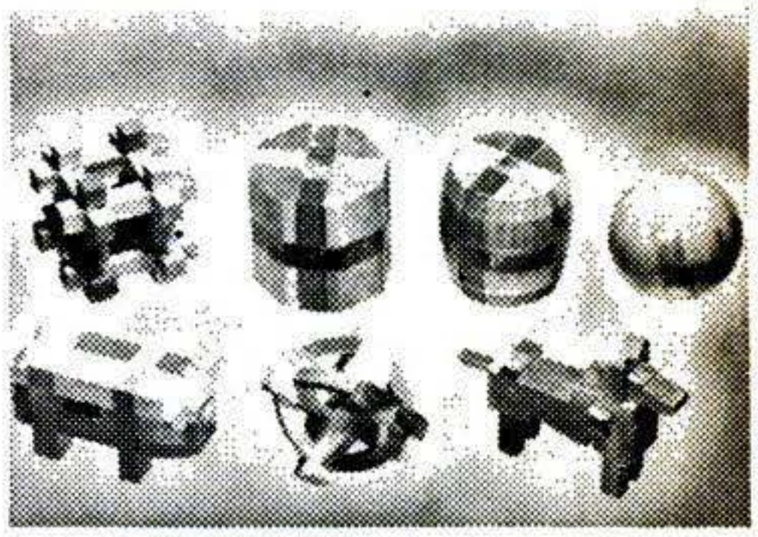

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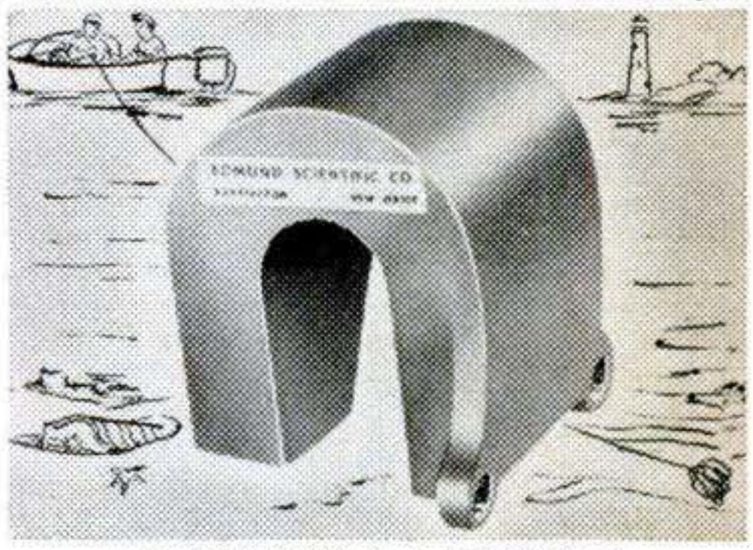

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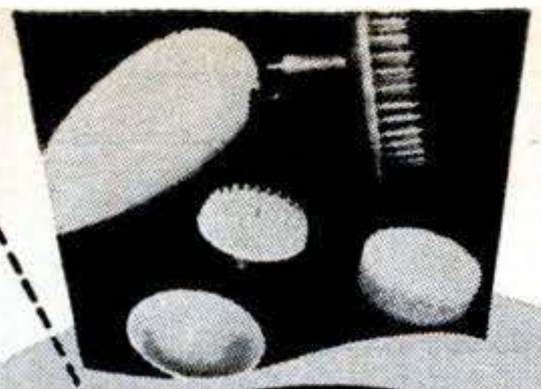

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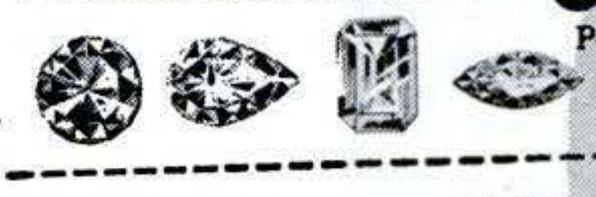

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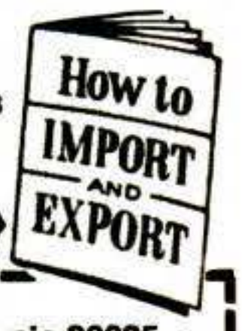

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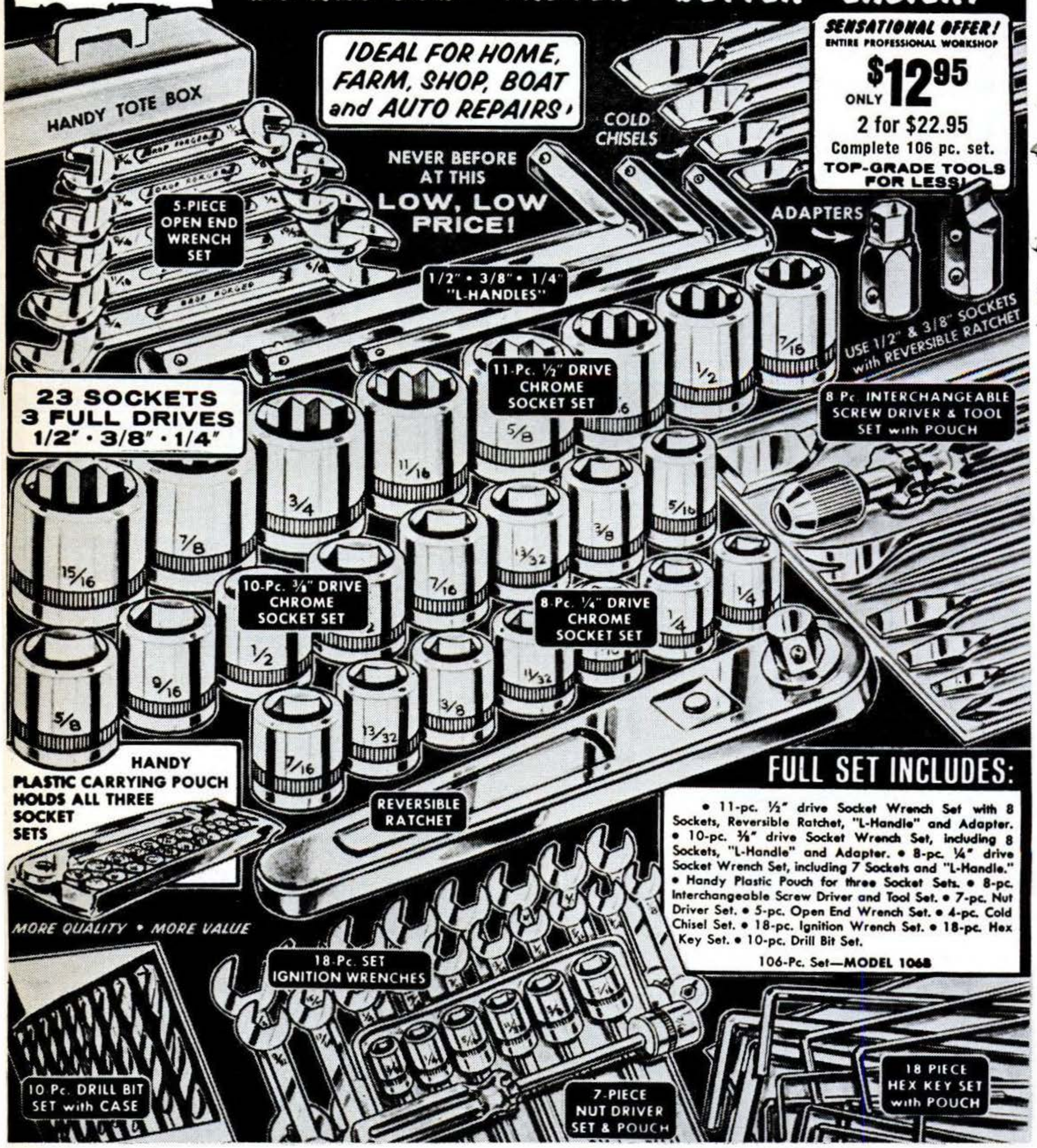

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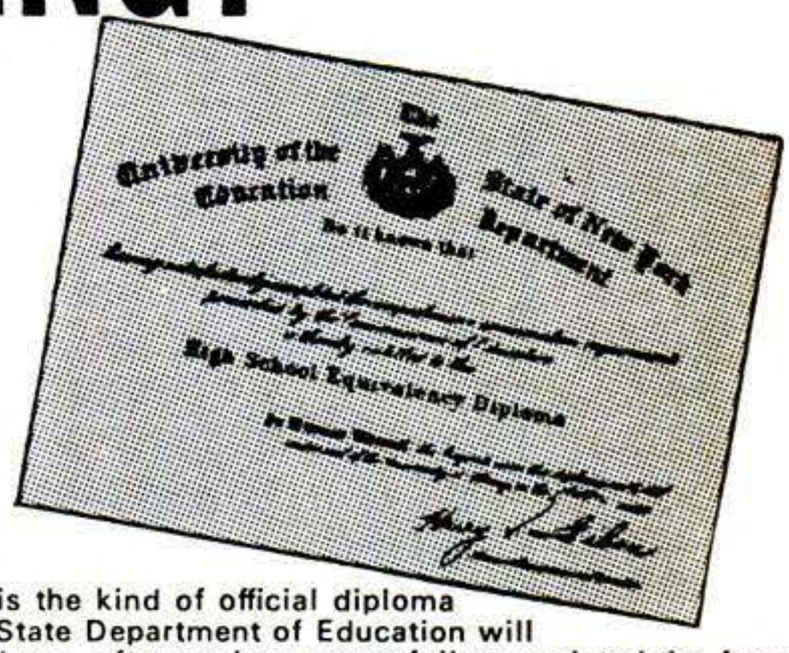

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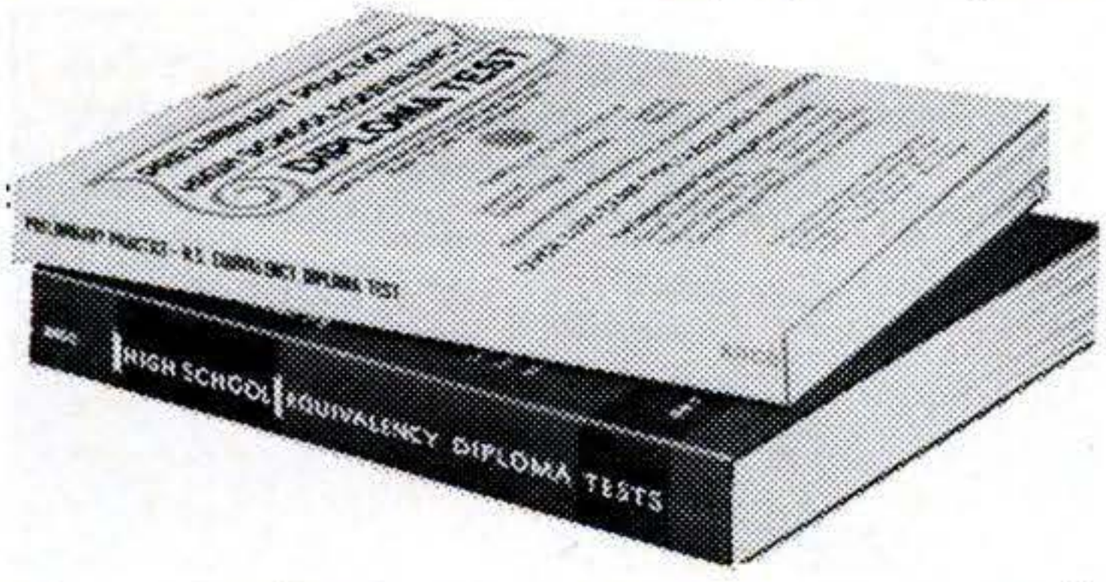

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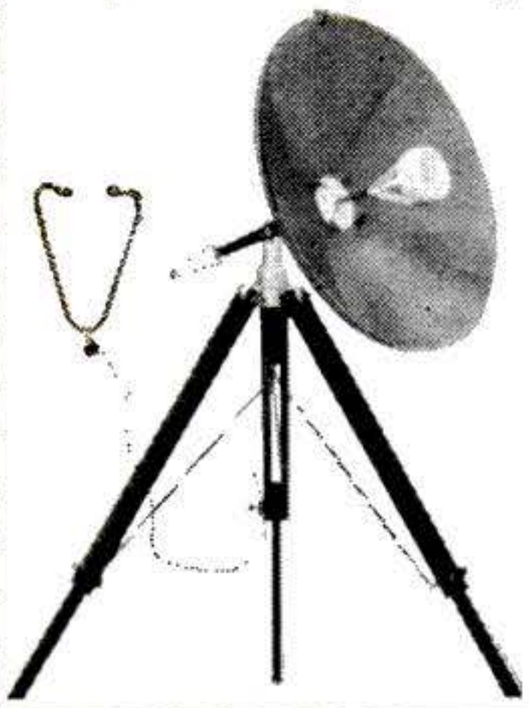

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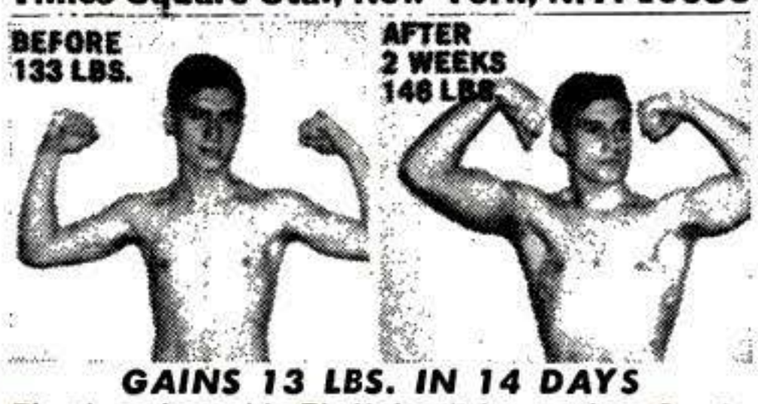

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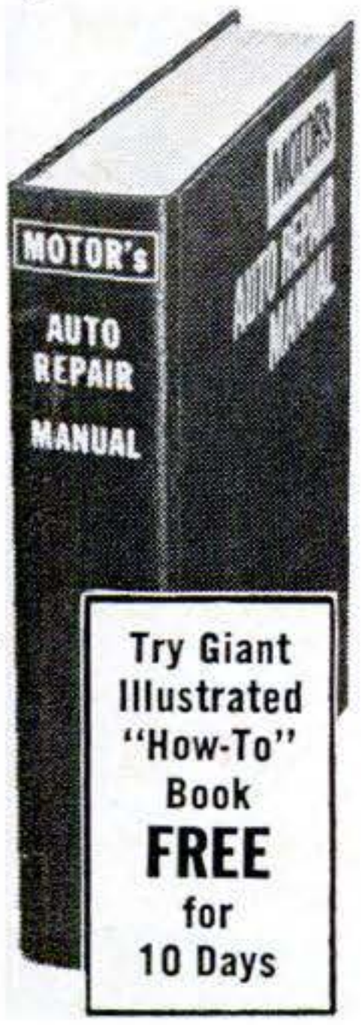

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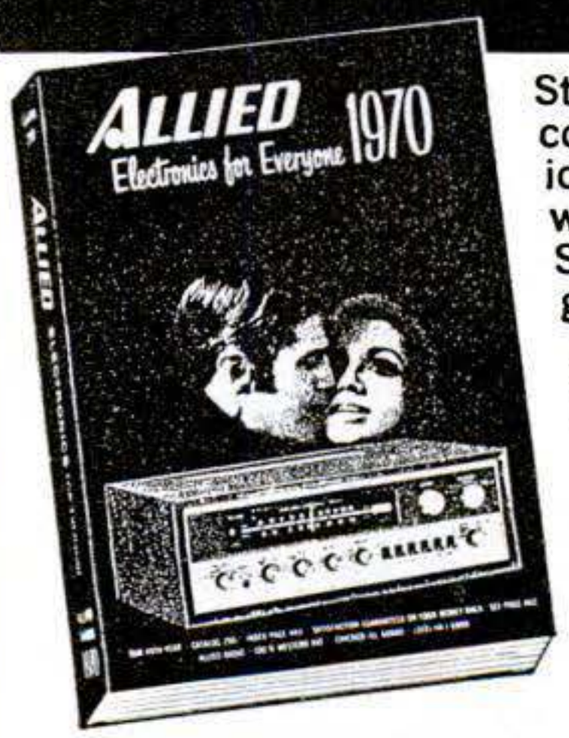

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  - ☐ Mitre Gauge for sander at $1.95
- ☐ Lathe at $14.95
  - ☐ Face Plate at $2.50
  - ☐ Turning Chisels at $4.95

G.E. Motor ☐ $18.80 (with other item) ☐ $24.85 (purchased separately)

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SAVE AS MUCH AS... 80% WITH QUALITY Amco POWER TOOLS

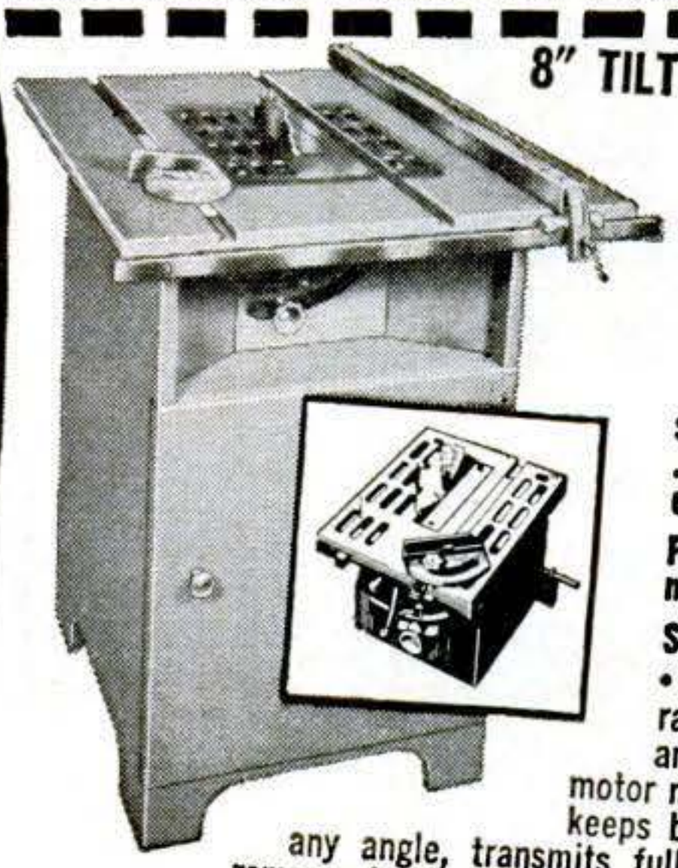
DIRECT FACTORY OFFER AND REVOLUTIONARY PATENTS decrease costs, increase efficiency. Full scale power tools of heavy duty 100% cast iron and steel. Streamlined design reduces weight, cuts material and production costs. Special patents provide added efficiency, accuracy, savings. Parts made, assembled, tested, packed right in our own factories shipped direct...save store profits.

UNCONDITIONAL 10-DAY MONEY BACK GUARANTEE
You must be fully satisfied. If not, return in 10 days, freight collect. Money promptly refunded in full.

ENDORSED BY AMERICA'S TOP MAGAZINES... Here is what the editors say: "A good bit of sound—imaginative—engineering." Popular Science; "(saw) boasts many features of bigger brothers." Popular Mechanics; "Amazingly versatile." Workbench; "Highly substantial construction, sturdy enough for production line use." Industrial Woodworking. And Workbench awarded these tools their coveted "Work Tested" Seal.

OVER A MILLION USERS confirm their precision, versatility and rugged performance.

✱10-YEAR FULL SERVICE GUARANTEE . . . Any part or parts of any AMCO power tool (except motor) which may become inoperative for any reason within **ten years** after the purchase date will be repaired or replaced by the factory without cost to the purchaser. Your only cost: for postage.



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DOES WORK OF $75 BENCH SAW as is. Converts easily to equal any $300 floor model cabinet units! Crosscuts, rips, mitres, cuts compound angles, dadoes, makes coves and mouldings.

$14.95 f.o.b. factory. Wt. 25 lbs. Includes completely assembled cast iron and steel 8" saw with ground cast iron table . . . less blade. RIP FENCE, if desired, for easier work alignment, $3.50 add'l.

PRECISION BALL BEARING SPINDLE for Commercial Service, $5.00 add'l.

SAW BLADE TILTS . . . TABLE STAYS LEVEL • Locks securely at any angle up to 50°, raises, lowers 0"-2¼". Patented tilt mechanism, accurate etched scale. Patented motor mount takes std. ¼ h.p. or larger motor, keeps belt tight, assures perfect alignment at any angle, transmits full power. Takes std. blade, saw insert removes to take dadoe heads, cutters, etc. (not incl.). Accurate mitre gauge assembly. Ground spindle. Enclosed steel base. "Compo" bearings. Accessories available at factory prices. RIP FENCE, if desired for easier work alignment: Std. size (for bench saw) $3.50; larger fence (for cabinet base, as ill'd.) $4.50.

FREE CABINET BASE PLANS Use as portable bench saw as received (inset photo) . . . or transform easily and inexpensively into floor model (as shown) guar. to do work of floor models costing $300. FREE plans . . . all you'll need are a sheet of ¾" plywood and 3-4 hours. Use your AMCO saw for cutting. Plans provide 27" x 24" work surface, 33" height, tool storage compartment.

10-YEAR FULL SERVICE GUARANTEE*

6" SWING 3-FOOT LATHE

$14.95 f.o.b. factory Wt. 14 lbs.

Optional faceplate for turning bowls, trays, lamp bases, rosettes, etc. $2.50.

Set of 3 high speed turning chisels, $4.95 add'l.

DOES THE WORK OF $40 UNITS . . . with same precision and speed. Turns wood, plastic. Sturdy cast iron with tubular steel bed. Ball thrust cup center, spur center, T-rest assembly, lever action tail stock, 2-speed pulley. Fits any motor.

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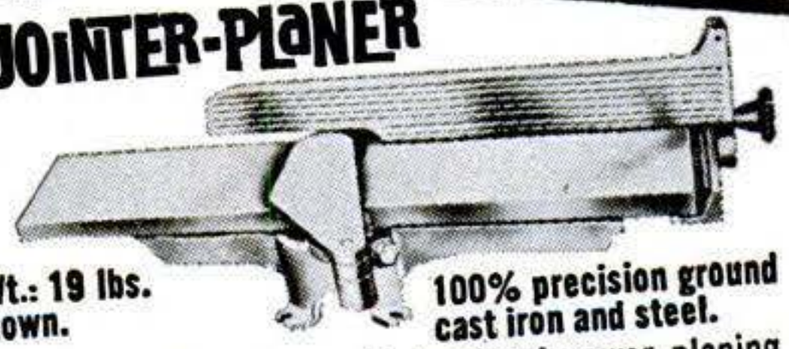
FULL 22" LONG, 4⅛" JOINTER-PLANER



$19.95

f.o.b. factory. Wt.: 19 lbs. Complete as shown.

100% precision ground cast iron and steel.

DOES THE WORK OF $60 UNITS . . . Professional power planing at a hand tool price. Make faster, more accurate joints, rabbetts, bevels for windows, doors, drawers, square tapered legs—Adjustable precision ground cast iron tables. Patent-pending design holds knife to table clearances at any depth. Rabbett depth ⅜". Fence adjustable 0°-50°. Hardened, ground hi-speed steel knives. Dual cutter guards. Balanced cutter head.

10-YEAR FULL SERVICE GUARANTEE*

PRECISION 4" x 36" BELT SANDER

Mitre gauge: $1.95 add'l.

f.o.b. factory. Wt. 15 lbs.

$14.95 †Disc Sander attachment incl. disc bracket, ground cast table (tilts 0-45°): $7.95 add'l.

DOES WORK OF $50 SANDERS . . . The world's most talented belt sander. Heavy cast sander incl. 4" x 36" sanding belt, V-pulley drive, multi-purpose drive spindle. Changes from horizontal to vertical sanding in secs. Uses ⅓ hp or larger motor.

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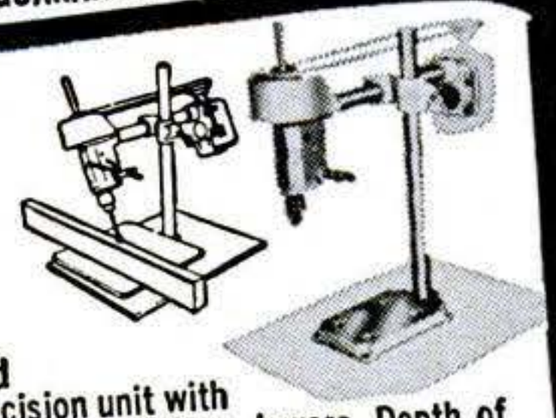
32" RADIAL DRILL PRESS



All cast iron and steel
f.o.b. factory Wt. 30 lbs.
½" cap.
Jacob's chuck incl.

$29.95

DOES WORK OF $90 UNITS . . . and much more. Industrial quality precision unit with all standard features, many extras. Head raises, lowers. Depth of throat up to 16". Pre-set to any angle for on-or-off table drilling, even horizontal drilling. **10-YEAR FULL SERVICE GUARANTEE.***

BRAND NEW GE MOTOR DEVELOPING FULL 1 HP . . . **$18.80** F.O.B. FACTORY / FOR ANY OF ABOVE MACHINES. WT. 17 LBS. PURCHASED SEPARATELY, $24.85

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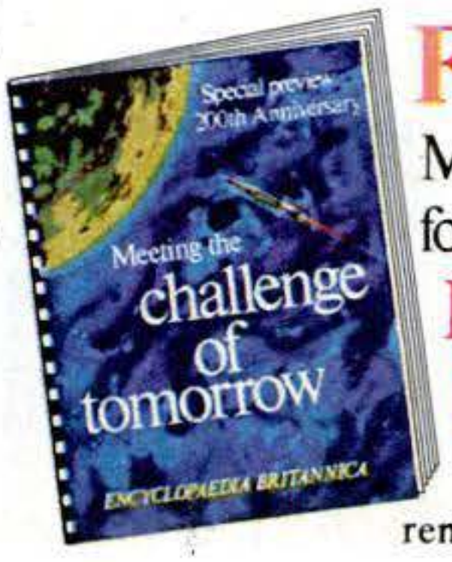

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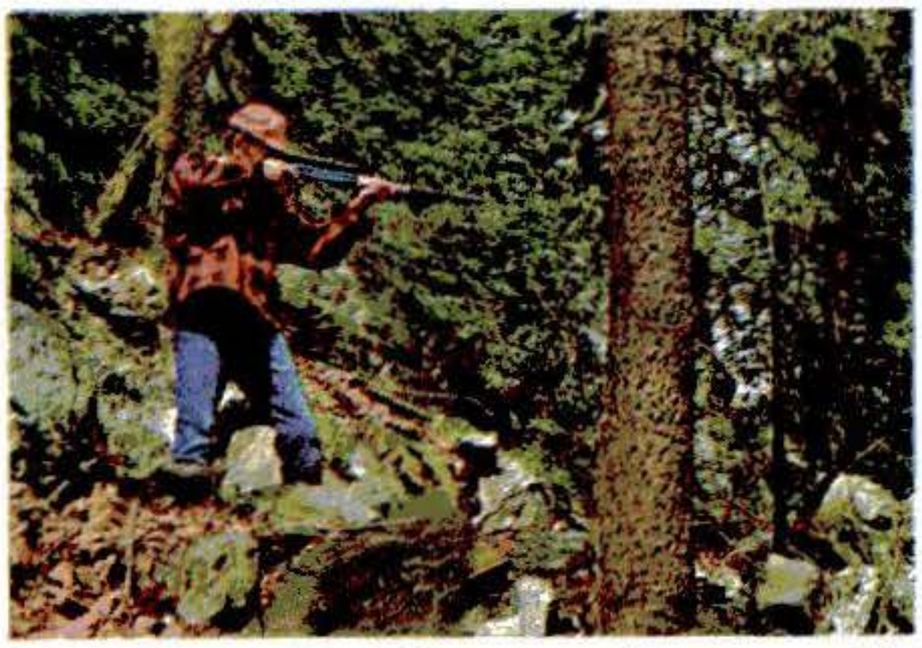
REMINGTON CLEARS UP SOME HIGH

Today the American big-game hunter choosing a rifle is faced with a bewildering assortment of calibers, models and styles. Here's how to pick the right Remington rifle for your hunting.

Remington wants you to have the right gun for your kind of shooting in your kind of territory. It just doesn't make sense going after an eastern whitetail with a 458 Mag. Or trying to produce a Kodiak-bear rug with a 6mm. Likewise, we tend to think that sizzling, high-velocity cartridges are a better choice for long-range shooting than they are for hunting in dense woods, where game is rarely shot at over 75 yards.

So, before you even look at guns, it might be a good idea to first take a



look at the modern big-game calibers today's Remingtons are chambered for. See what is best for your hunting. Then we can help you pick the rifle to shoot it.

Here are the calibers most hunters agree are right for *short-range shooting*.

- 44 Rem. Mag. ■ 30/30

For *medium- and long-range shooting* these are a good choice:

- 6.5mm Rem. Mag.
- 280 Rem.
- 7mm Rem. Mag.
- 264 Win. Mag.
- 270
- 30/06
- 308 Win.

These we call *powerhouse calibers* for knocking down big bear, elk and moose.

- 7mm Rem. Mag.
- 350 Rem. Mag.
- 300 Win. Mag.
- 375 H&H
- 458 Win. Mag.
- 30/06

And finally a pair of *combination varmint-small deer* cartridges.

- 6mm Rem. ■ 243 Win.

A properly expanding bullet, like the "Core-Lokt" bullet shown at the right, should be used with all of the rifle calibers listed above. "Core-Lokt" bullets hold jacket and core in one piece, yet mushroom to over twice their original caliber for maximum shocking power. These game stoppers are loaded in 26 different big-game calibers and in both Remington and Peters cartridges.

"Core-Lokt" bullet mushrooms to twice its caliber.

A good choice for medium and big game — especially in heavy brush — is the "Core-Lokt" Soft Point. For maximum, rapid mushrooming we suggest the "Core-Lokt" Hollow Point. For long range we recommend the "Core-Lokt" Pointed Soft Point which gives flatter trajectory and maximum striking velocity at greater distances. Remember, more big game has been dropped with "Cor Lokt" bullets than any other bullet.

Choosing the right gun

If you want fast follow-up shots moving targets, plus easy carrying si and weight, your choice should b either an automatic or pump-actio rifle. (Although our 660 bolt-action ca bine is mighty handy, too.)

If you're going after Alaskan brown and grizzlies and want the tremendou knockdown power of the heaviest cal bers, then it's hard to bea a Remington bolt action And, of course, many hun ers have a personal pre erence for the bolt actio and choose it for th lighter calibers, too.

One more important choic

That's the make o gun you want. Since ou name happens to b "Remington," it won come to you as a grea surprise that we recommend Reming ton rifles. However, we think we ca prove to you that, gun for gun, Rem ingtons have solid advantages ove their competitors. They're built to giv you more buck for your bang. And vic versa.

Remington makes big game guns in five basic mod els — most of which come i standard and deluxe versions Here they are:

Model 760 Pump Rifle. Th is the fastest hand-operated big game rifle on the market. And the onl

Model 760 BDL Pump

Model 742 ADL Automatic

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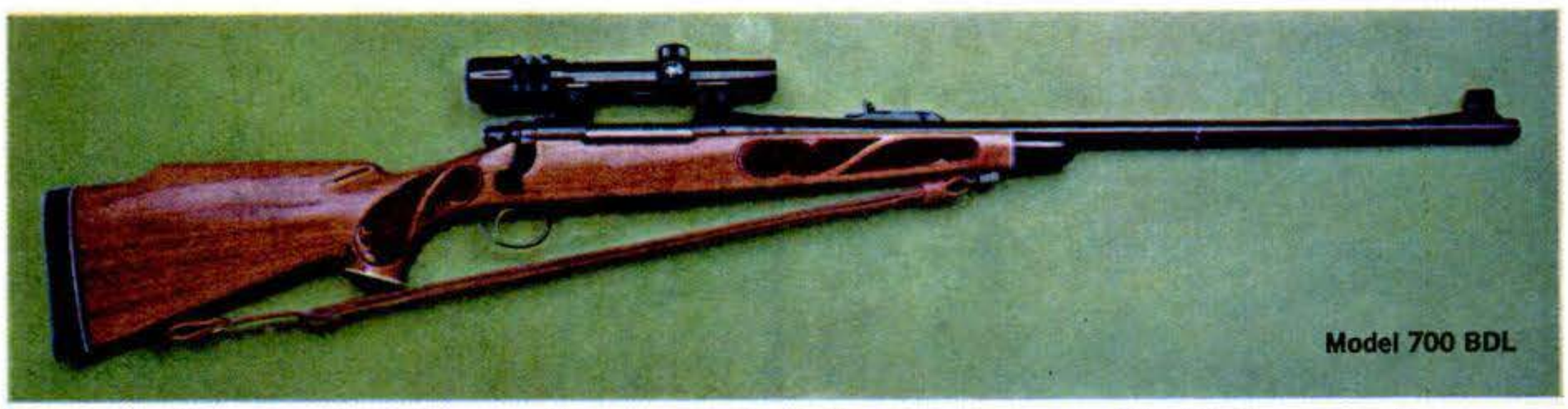
POWER CONFUSION.


Model 700 BDL

mp-action rifle
t can handle such
t loads as the
/06 and 308 Win.
really a kind of
olt" action with
ong locking lugs
and it's operated
by pumping.
Comes in both
22" barrel and
18½" carbine
barrel lengths. Big-game calibers: 270 Win., 30/06, 308 Win., 243 Win., 6mm Rem. Four-shot removable clip magazine. Prices start at $139.95.* A perfect rifle for the man used to a pump shotgun.

Model 742 Automatic. Remington developed the first really successful automatic, big-caliber sporting rifle. This model 742 has proved itself to American hunters — year after year after year. Gas-operated, dependable and fast. Handles real big-game cartridges—not souped-up pistol ammo. Points so naturally you get on your target before it gets into the brush. Four-shot removable clip magazine. Calibers: 280 Remington, 30/06, 308 Win., 243 Win., 6mm Rem. Available in both carbine and rifle. Prices start at $159.95.*

Model 788 Bolt Action. No fancy frills. Just solid, rugged, long-lasting durability and accuracy. One reason for superb accuracy: the fastest lock time of any center-fire rifle. It also has one of the strongest actions ever put in a rifle (9 locking lugs). Priced at $89.95*. We think that the 788 is the outstanding rifle buy this year (or any year). Calibers: 30/30, 308 Win., 44 Rem. Mag., 6mm Rem., 243 Win.

Model 660 Bolt-Action Carbine. Power to knock down any game in America in a handy package that will slip into a saddle scabbard. Has a new bolt shroud to keep out dirt, grit and bad weather. World's strongest bolt action with three rings of solid steel around the cartridge head. Special barrel bracket for rugged scope mounting. Big-game calibers: 308 Win., 350 Rem. Mag., 6.5 Rem. Mag., 243 and 6mm Rem. Priced at $119.95* in standard calibers—$149.95* in magnum calibers (laminated stock).

Model 700 Bolt Action. Since its introduction, shooters have bought more Model 700's than any other center-fire bolt-action rifle on the market in its price class. Which is understandable. From its ramp front sight to its white-line buttplate, the 700 BDL just oozes quality and care and craftsmanship and superb materials. This year the stock has been restyled, the bolt head shrouded, and a low-profile safety and a jeweled bolt added. Your choice of either a deluxe rifle (ADL) or a custom deluxe rifle (BDL). This one doesn't even come in a "standard" grade. But the prices start down around $134.95.* 12 big-game calibers from 458 Win. Mag. to 6mm Remington.

Want to know more?

There are two things you can do. One, drop in on your Remington dealer and talk guns. Don't worry about maybe not being quite ready to buy. We've never seen a man back of a gun counter who wouldn't rather talk guns than eat . . . and if you happen to buy something, he won't object. The people that handle Remington guns want to serve you as much as they want to sell you. And that's a fact.

The other thing to do is to send for a free Remington 1969 catalogue. It's loaded with pictures, facts and figures . . . worth having in your gun closet, whether you're gun shopping or not. Besides, it's free!

Just write Remington Arms Co. Bridgeport, Conn. 06602—Dept. F10.

Remington DU PONT PETERS

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Model 788

Model 660 Carbine

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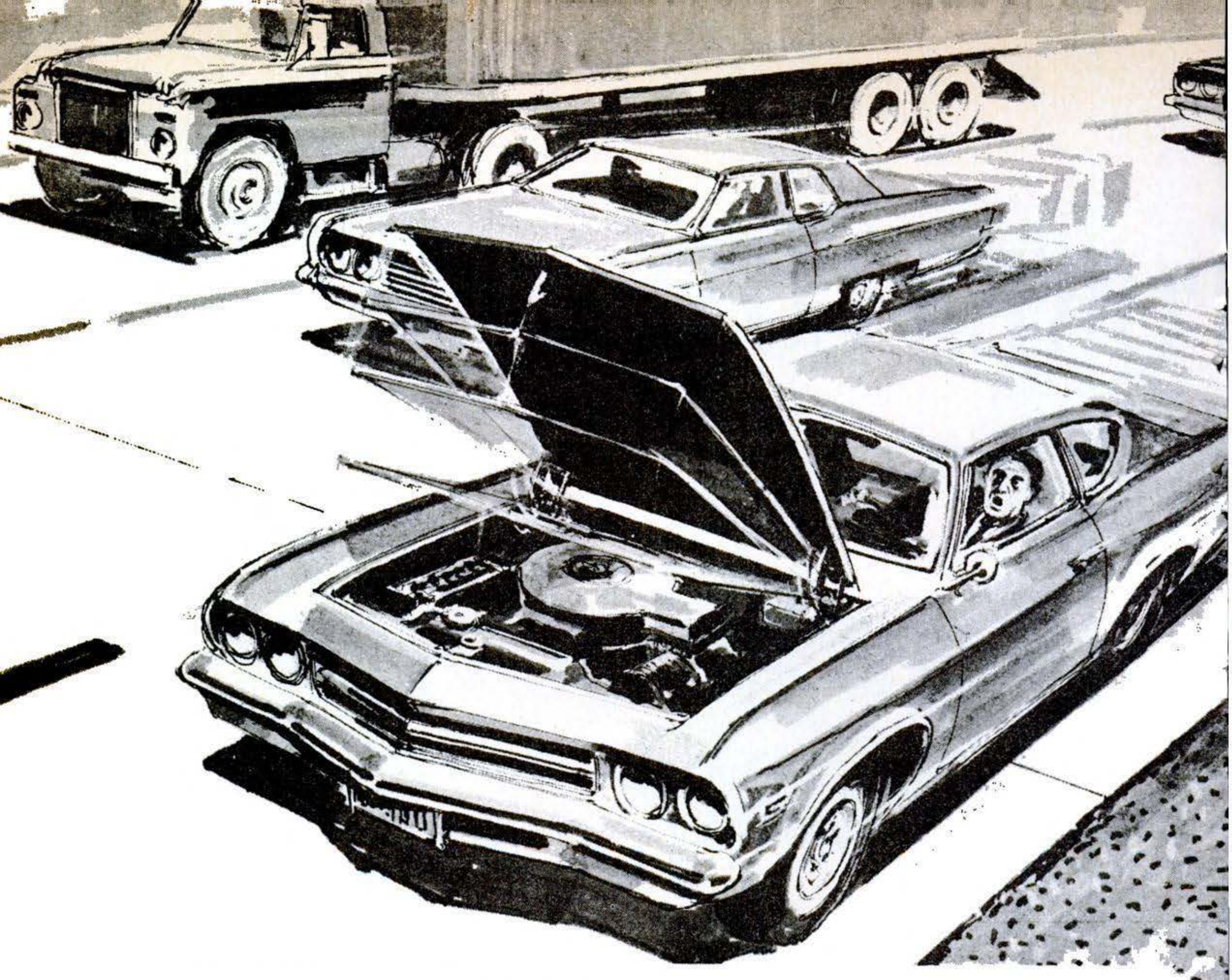

THE SKILLFUL DRIVER 1

If Your Hood Flies Open...

Panic is the most important thing to avoid if your hood flies open. Don't hit the brakes. Get off the throttle, lay your head against the door, and peer around the edge of the hood. At first chance, open your window and lean out. Some hoods leave a gap so you can see ahead through the bottom of the windshield. Decide on which shoulder you can stop. Never stop in the roadway. The situation above could cause a multi-car pileup, because the drivers behind you are not prepared for a sudden stop.

Don't use your emergency flasher —you'll need your turn signals. If you're on a freeway, pull off cautiously and park. Look in the mirrors before changing lanes, and slow down gradually. Make the most of your clear rear and side vision.

Have you ever been in an emergency situation on the road, and got out of it in masterly fashion? Have you had a narrow escape from a dreadful collision? Other drivers would like to know your experience—and your expert advice. PS will pay $25 for your contribution, if selected for publication. Send it to Skillful Driver, POPULAR SCIENCE, 355 Lexington Avenue, New York, N.Y. 10017.

(We take the fun of driving seriously.)

ontiac Motor Division

The Humbler.

1970 Pontiac GTO. So dazzling we've dubbed it "The Humbler."

Listen up. You'll catch on. The basso burble comes from a new performance exhaust you can order.

Of course, pipes can't do it alone. Standard Humbler is a 400 V-8. But you can order a new 455 V-8. Or one of the Ram Air engines.

You can also specify the Hurst-stirred 4-speed, instead of the standard 3-speed.

About now, a lot of pseudo performers are wishing they could slither off to a nice, quiet garage.

GM

MARK OF EXCELLENCE

3 individual color pictures of Pontiac performance cars, specs, book jackets and decals are yours for 40¢ (60¢ outside U.S.A.). Write to: '70 Wide-Tracks, P.O. Box 888, 196 Wide-Track Blvd., Pontiac, Mich. 48056.

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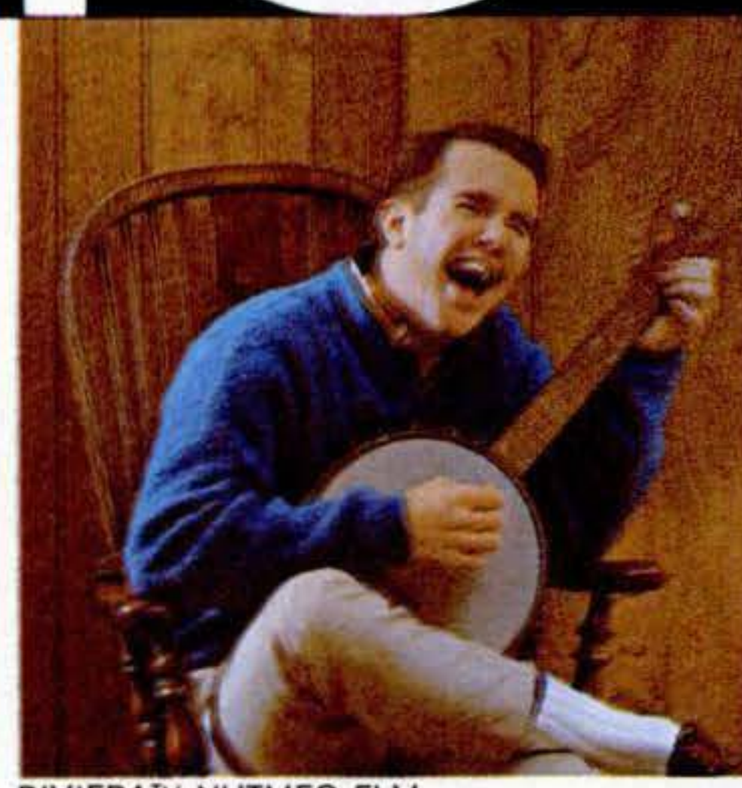

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In the species, wood grains, and colors you're looking for!

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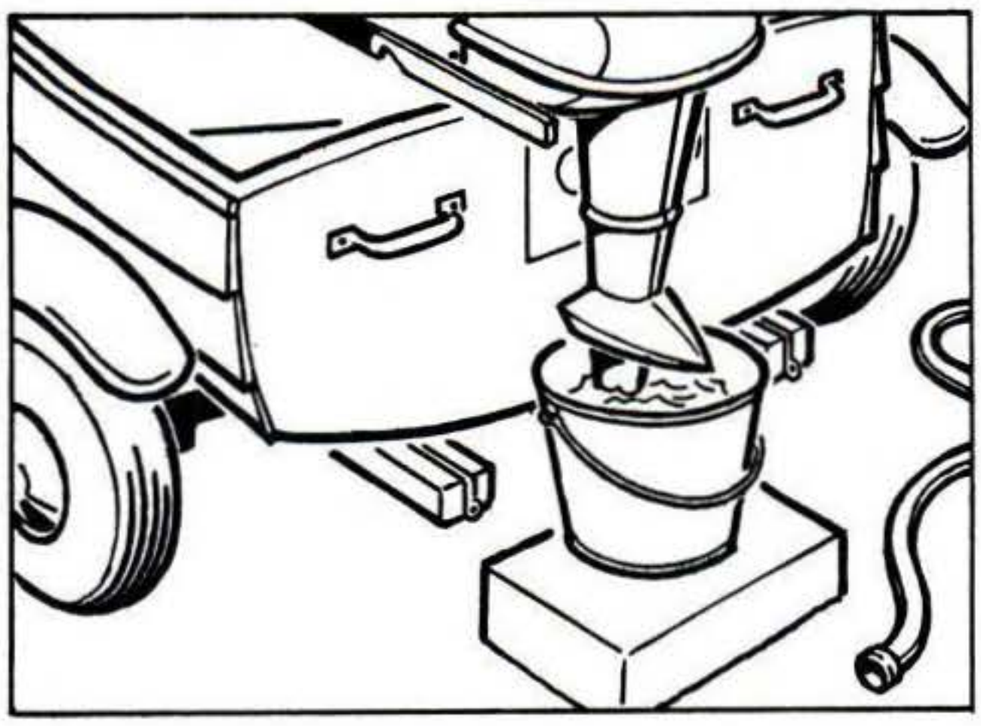
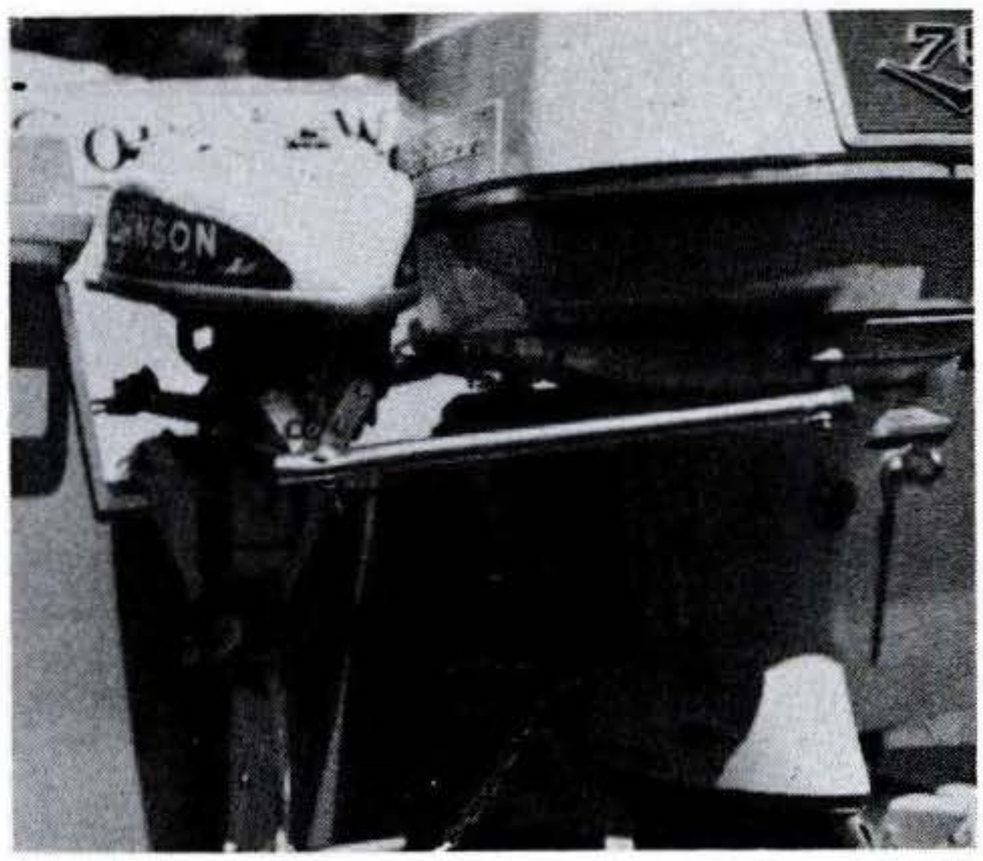


Quick rinse stops corrosion

Corrosion won't have a chance to get started in your outboard's cooling system if you rinse it out well after each tour of duty in salt water. I prop a pail or other container with fresh water in it up around the propeller so the intake and exhaust holes are submerged. Running the engine a few minutes circulates the clean water through it, flushing out salt.

FRED STAFF, Stanton, Calif.



Steering link for two motors

The steering wheel on my outboard boat turns the cruising and trolling motors together through a length of 1"-diameter aluminum tubing. A right-angle bracket is fastened to the smaller motor, its mounting holes made to line up with cylinder head. The cylinder-head cap screws hold it in place. The aluminum tubing is mounted on the main motor with a ⅜" cap screw, and its other end fastened to the bracket with a ⅜" pin and cotter key. To reduce drag when cruising, the link is readily disconnected and the small motor is then tilted out of the water.

JOHN H. SCHMIDT, Pollock Pines, Calif.

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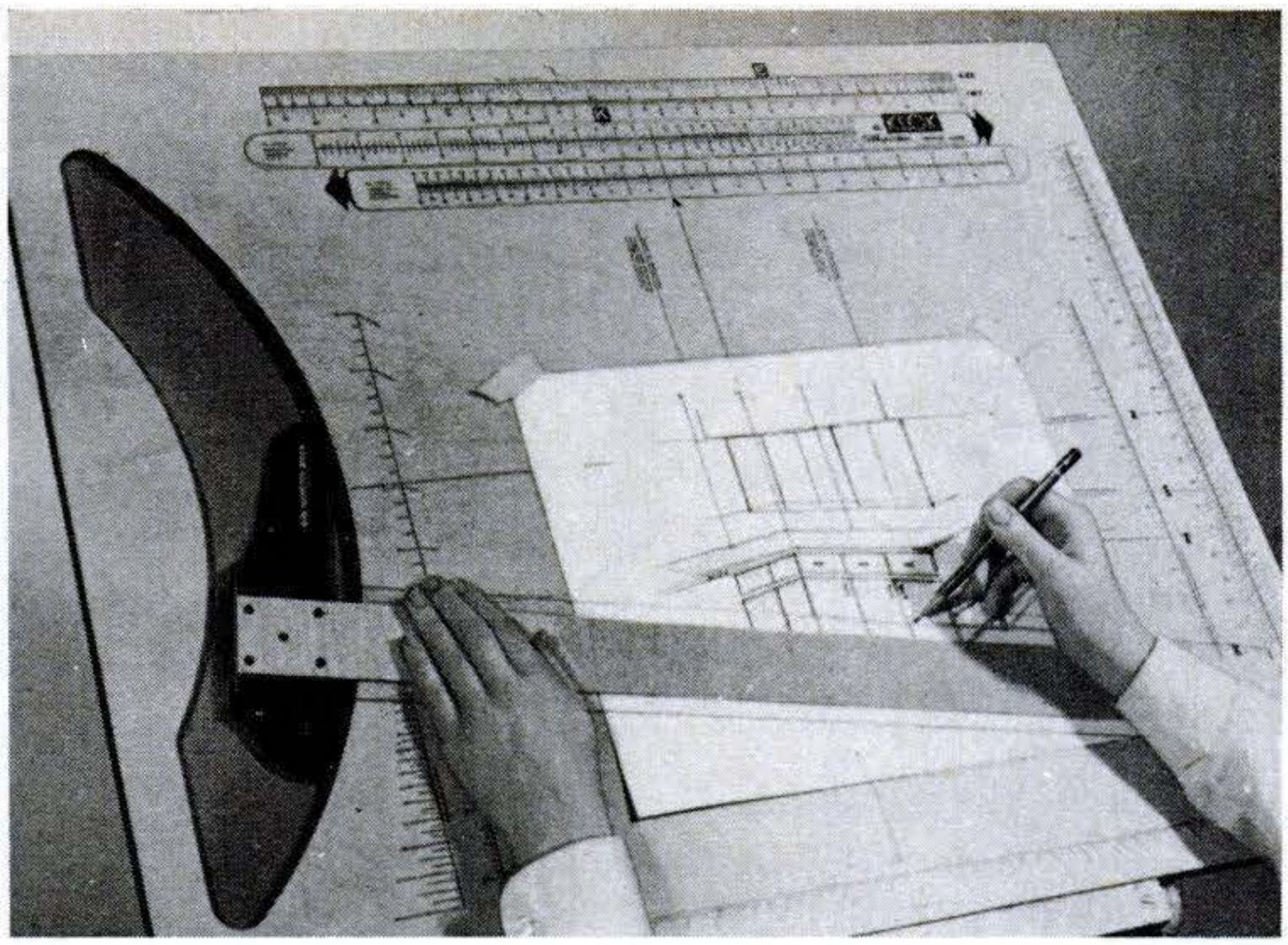
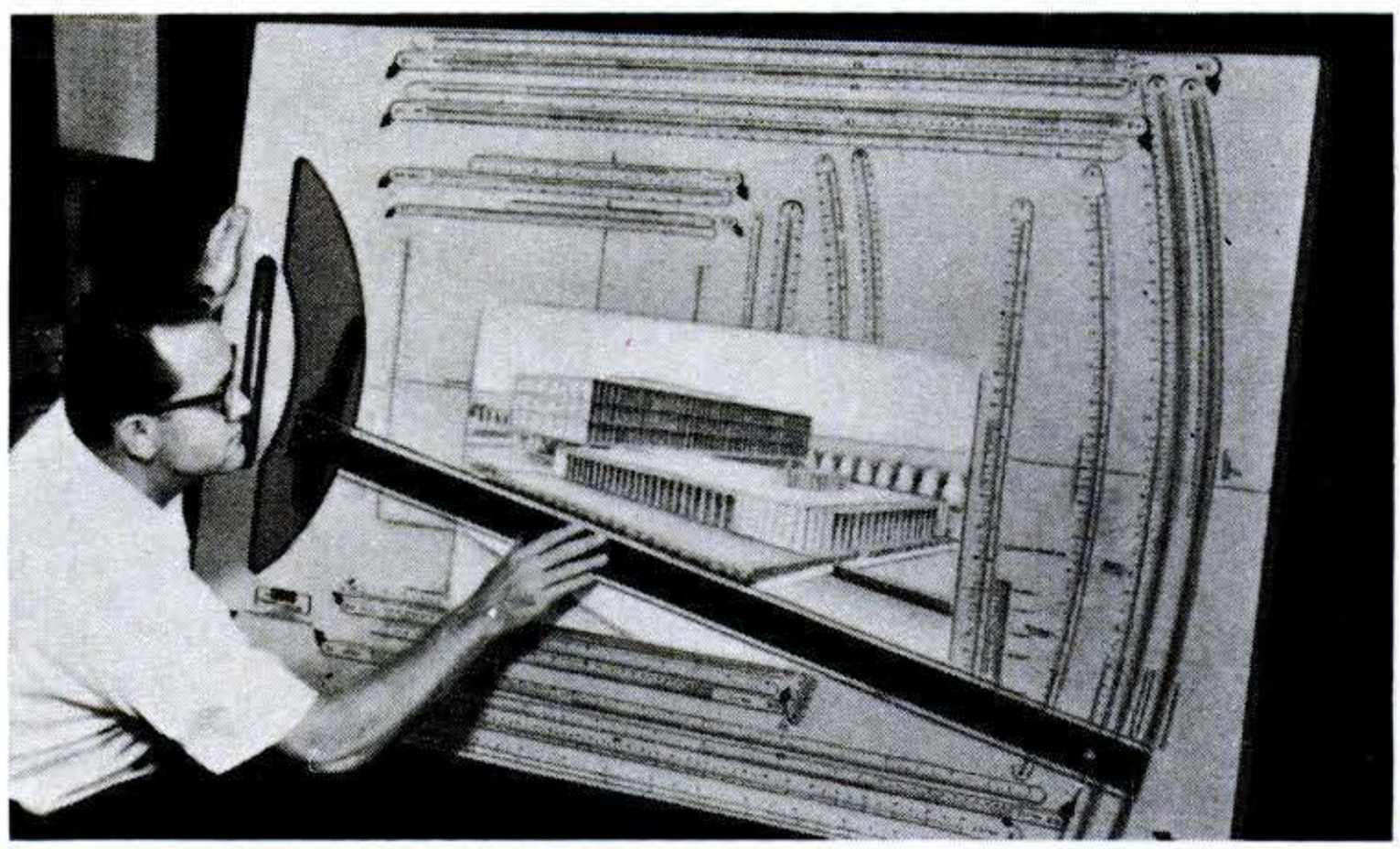
The Drawing Board That Turns You Into an Artist

By E. F. LINDSLEY



Standard 24-by-30 board is fine for home-shop and remodeling projects. Scales show the best angles for perspective. Below: 38-by-60 pro board.



Did you ever have to go "back to the drawing board" when your latest project went wrong? Well, now there's a drawing board that won't let you make mistakes in the first place. With the Klok board, even a relatively inexperienced draftsman can turn out eye-catching drawings to accurate scale.

You can, for example, design new kitchen cabinets to fit into a measured space; working dimensions and materials sizes come directly from the drawing. Better yet, your wife can see what the finished job will look like before you start—and she can make her suggestions at the drawing stage instead of at the carpentry stage.

The Klok perspective boards are unique. Although not new, they've been steadily perfected and are now made of a new panel material—solid plastic Fiberesin—that is very dense and doesn't warp or stain. It has scales under, not on, the smooth surface. Also, the boards now come in three sizes: 24-by-30, 28-by-39, and 38-by-60 inches ($35, $95, and $150, from Modulux Div., U. S. Gypsum Co., Box 88, Oconomowoc, Wis. 53066).

How do you make those great perspective drawings? Easy. A special T square swings in a groove that automatically locates the left-hand vanishing point beyond the physical limits of the board. Marks on the board help you locate perspective eye lines and base lines. Working dimensional scales, with built-in foreshortening, eliminate all calculations.

My experience showed that many drawing methods—isometric, eyeballing, drawing on grid paper—can be replaced with the Klok board. It worked best for me in turning roughed-in ideas into accurately scaled perspectives.

An instruction manual and sample drawings teach you in minutes how to use the board. It can also, of course, be used as a conventional drawing board.

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new breed of scat

The Bobcat, from Evinrude

Evinrude driver takes the Bobcat over a test jump. (Leave this to the "pros"—it's tricky.)

the performance-plus snowmobile

Most "performance" snowmobiles are stripped-down, single-purpose speed machines.

The Evinrude Bobcat is a high performance *trail* machine. A world of difference.

Bobcat is designed for speed—*plus.*

50 mph speed in flat country. With *power in reserve* for hill climbing and high altitude running; and for powering through deep powder and soft, sticky snow.

The secret is the Bobcat engine—a 25 hp Evinrude twin with enormous 437 cc displacement.

An engine big and powerful enough so the whole machine can be made as strong and tough as it needs to be for high speed cross-country running.

With enough performance left over to take a little luxury along.

Man can't live on speed alone.

Write for catalog. Evinrude Motors, 4088 N. 27th St., Milwaukee, Wis. 53216

the trailblazers, from* EVINRUDE** *Div. of Outboard Marine Corporation* ***first in outboards

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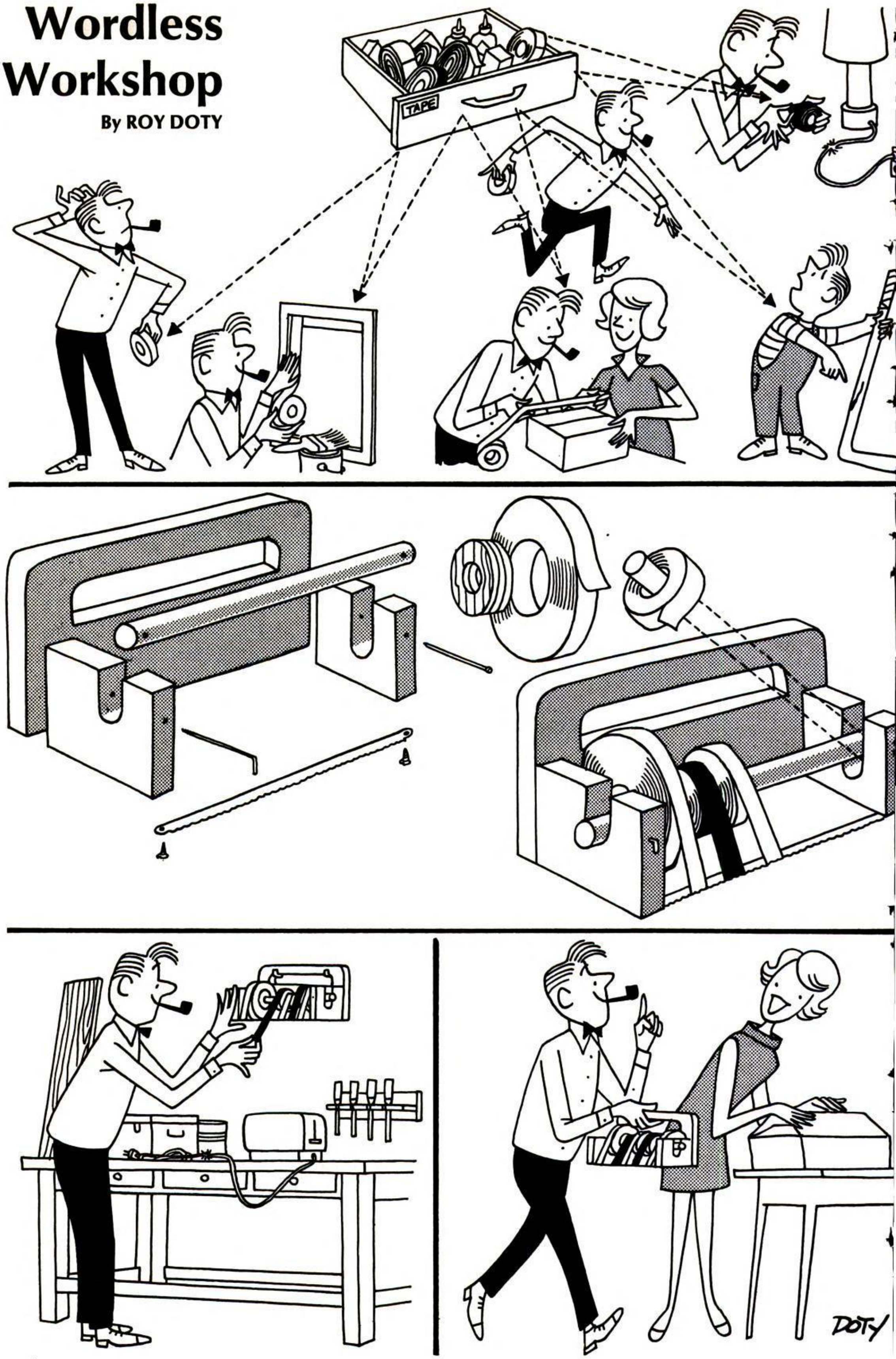
Wordless Workshop

By ROY DOTY



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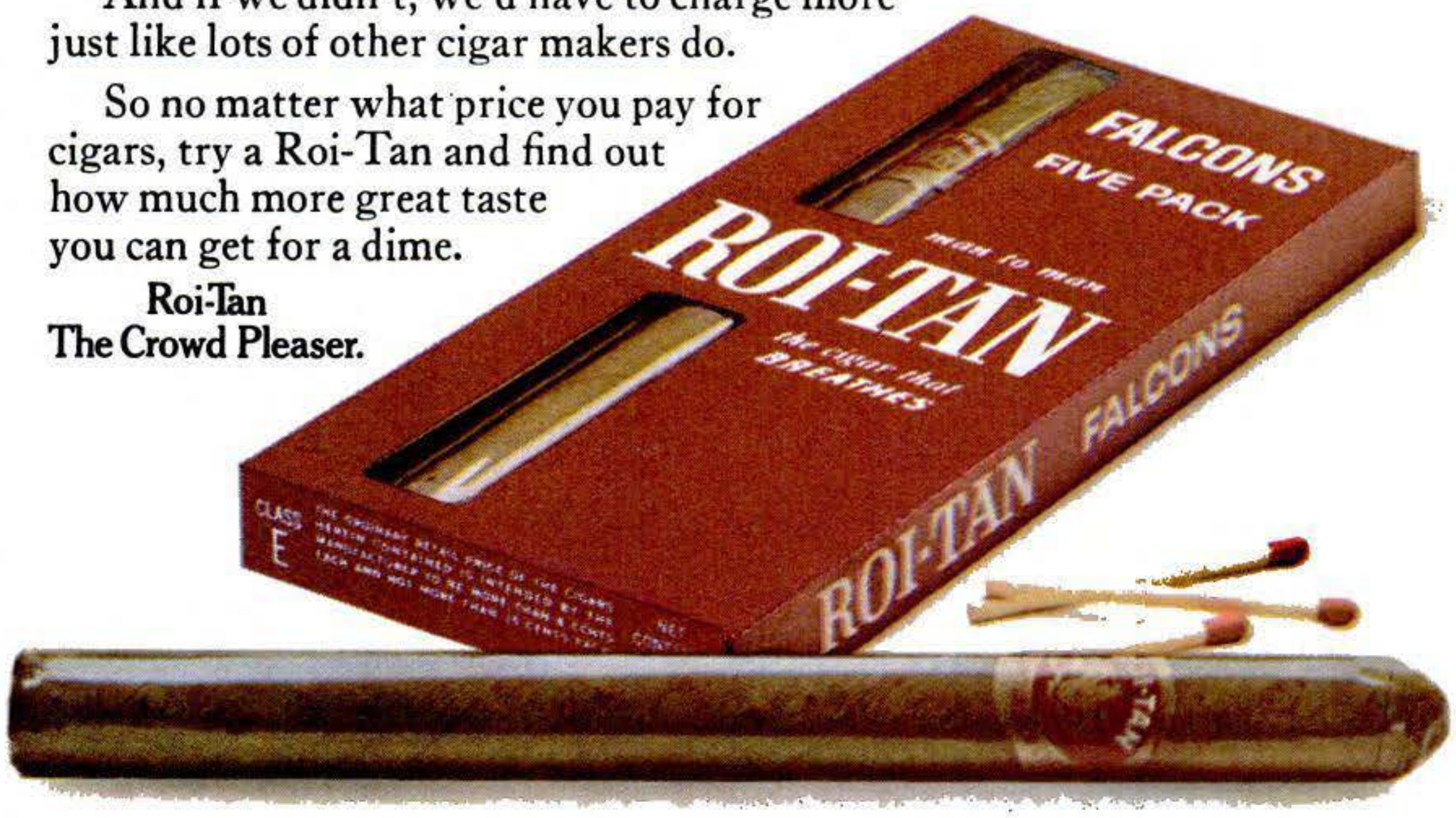
If Roi-Tan wasn't the best selling ten cent cigar, you couldn't buy it for ten cents.

There's only one reason you can buy a fine tasting blend of imported and domestic tobacco like Roi-Tan for only a dime. The fact that we make so many of them.

And if we didn't, we'd have to charge more just like lots of other cigar makers do.

So no matter what price you pay for cigars, try a Roi-Tan and find out how much more great taste you can get for a dime.

Roi-Tan
The Crowd Pleaser.



Stylishly long slender cigars are becoming more and more preferred by today's cigar smoker. Another reason why the Falcons are one of the more popular of the many Roi-Tan shapes and sizes.

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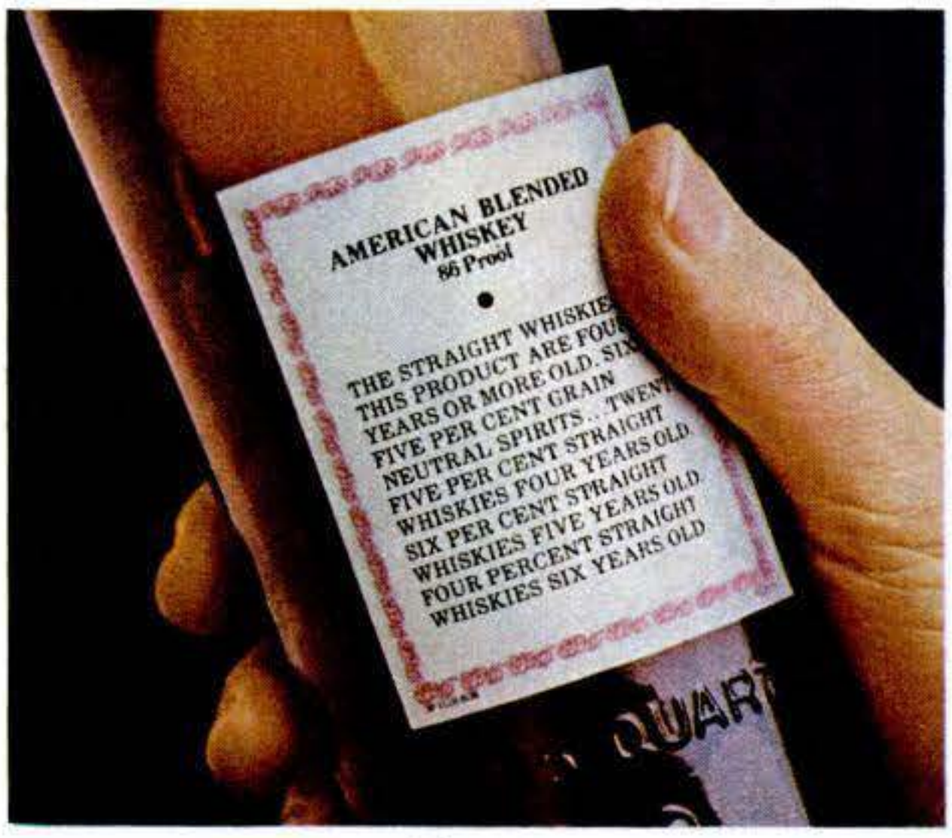
Eight year old whiskeys
vs.
four, five and six year old whiskeys.

Ours



Theirs

The straight whiskeys blended* in Schenley Reserve are older.

And older whiskey
tastes more mature. Smoother.
It costs more to make.
So compare the age. Compare the price.
And if you're paying Schenley Reserve prices for something younger, don't think that they're charging too much.
Maybe we're just charging too little.

Schenley Reserve.
It costs more to make. Costs us. Not you.

*Blended Whiskey · 35% Straight Whiskeys
65% Grain Neutral Spirits · 86 Proof ©Schenley Distillers Co., N.Y.C.

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Popular Science
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Sensational New Mercedes Has Triple-Rotor Wankel Engine

Most powerful rotating combustion engine yet installed in a car gives 175 m.p.h. speed

By JAN P. NORBYE / *PS Automotive Editor*
PHOTOS BY JULIUS WEITMANN

Experts have been telling you for the past two or three years that it's all over for the Wankel engine. In terms of exhaust emissions, it's worse than the piston engines we've got, they say. And its high amount of unburned hydrocarbons is mainly caused by its high surface-to-volume ratio, which is inherent in the design. Curtiss-Wright has failed to get its Wankel engine adopted by any Detroit manufacturer and, as of this moment, only NSU in Germany and Toyo Kogyo in Japan

Continued

Clay model (foreground) was made for initial evaluation and wind-tunnel testing. Next step was full-scale mockup with real wheels but no interior. From this picture to the one below, about three years went by, while chassis and running gear were designed, and power plant got intensive development.

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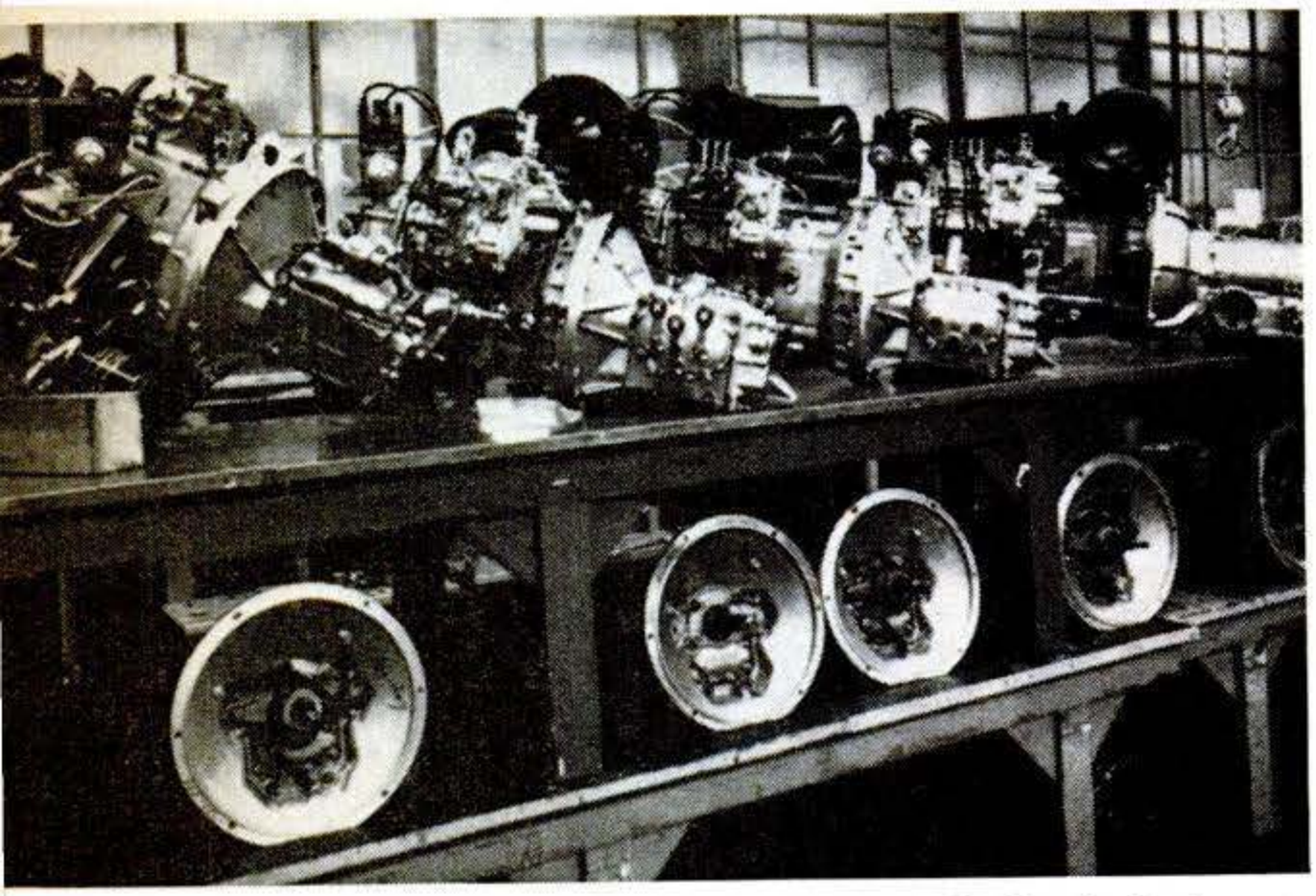
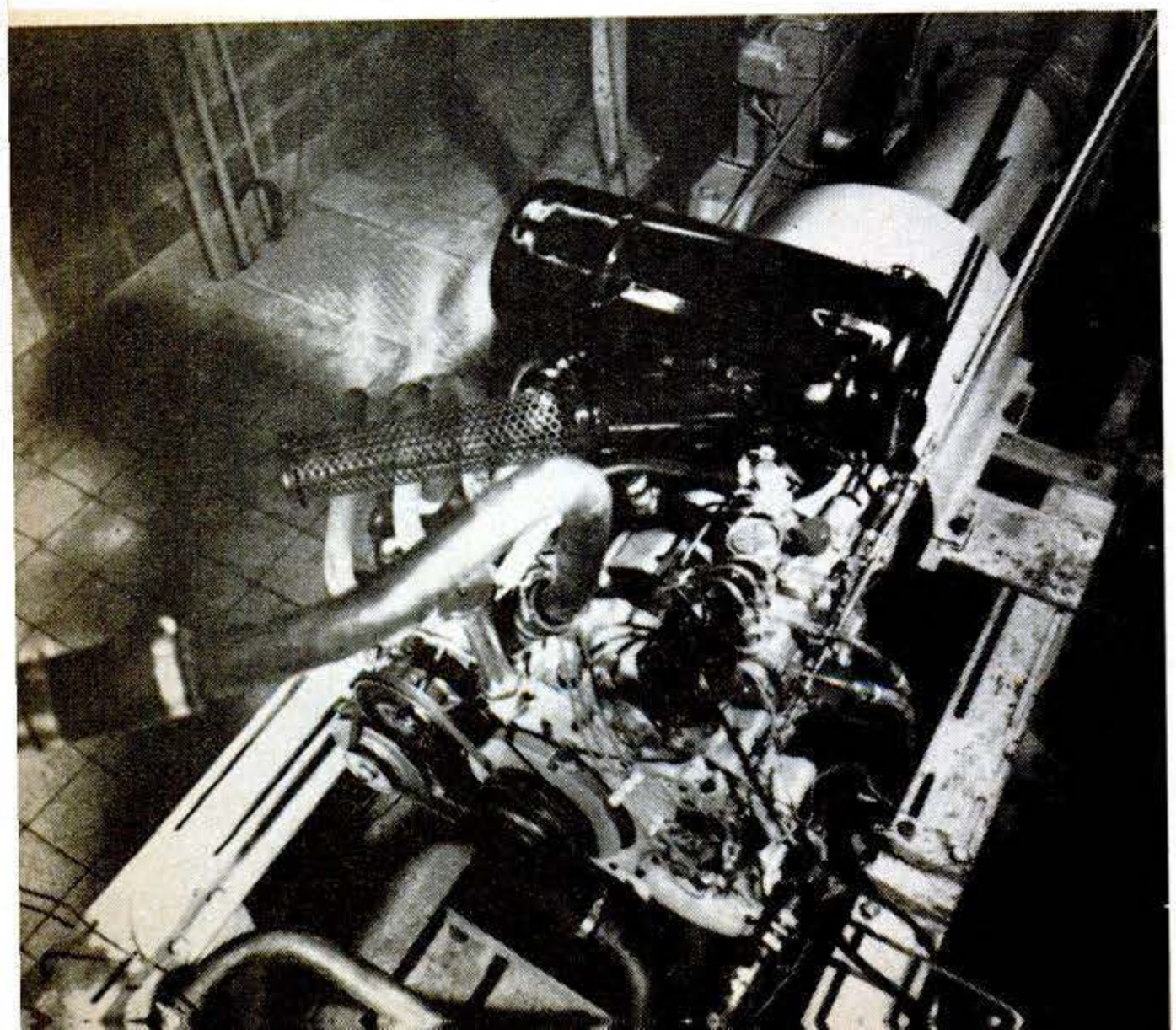
Engine "block" is actually made up of three sectioned housings, one for each rotor. Side intake ports are used for best torque over wide r.p.m.



Finished engines here await installation in test cars. Clutch and flywheel housing are bolted directly to the five-speed all-synchromesh transaxle.

On the test bench, and complete with own ignition system and fuel-injection pump, but using open exhausts, compact, light engine produces 300 hp.



have Wankel-powered cars in production. None of their power units meet our air-pollution standards.

But this month, Mercedes-Benz begins limited production of the C-111 (code name), a completely new car with a triple-rotor Wankel engine. When a company with one of the largest, most respected and renowned engineering staffs of any automobile maker in the world gets behind the Wankel engine, you suddenly see that the experts may have to eat their words. Mercedes-Benz racing cars won just about everything they set out to win when they had a racing department. The company has an unequalled reputation for engineering brilliance, thoroughness, and imagination. And you can bet they found some pretty good reasons to put a Wankel engine in this new sports car—especially since Mercedes already makes a fine, high-performance overhead-camshaft V-8!

Why go to a Wankel? Above all, a 100-percent improvement in power-to-weight ratio. The triple-rotor Wankel weighs only half as much as the 300-hp. 385-cubic-inch V-8. It's also less bulky, and therefore far-better suited for midships installation in a sports-car chassis. Its noise and vibration levels are lower than a V-8's, which simplifies engine mounting and insulation systems. But—and here the experts butt in again—its thermal and mechanical efficiency are no higher than in a modern piston engine, and can it ever hope to meet U.S. emission standards? I think it can.

From unofficial sources, we know a great deal about Mercedes' work on Wankel engines, and have compiled this preview of the first true "Car of the Seventies," without cooperation from the factory. Our photos were also obtained privately.

Mercedes-Benz bought a license to make Wankel engines of 50 horsepower and over in October 1961, and started development work on a twin-rotor engine right away. Within two years, they decided to go to three rotors—for several reasons. More rotors mean more combustions per output-shaft revolution, which results in reduced torque fluctuations. That, in turn, cuts noise and vibration.

Beyond that, it was found that the hexane content of the exhaust gas is greater when the displacement of each combustion chamber is greater. With more rotors,

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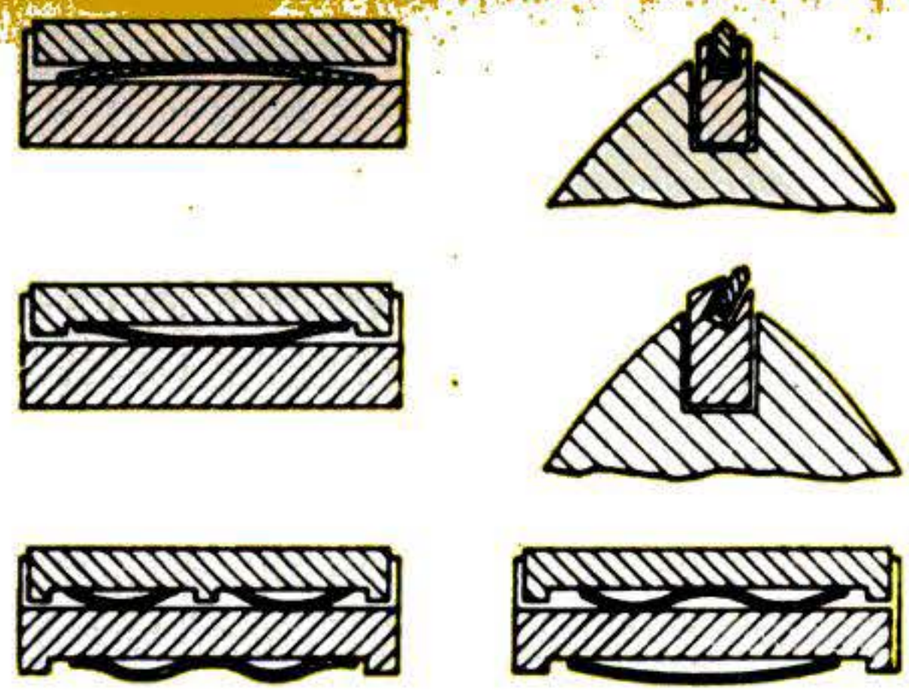
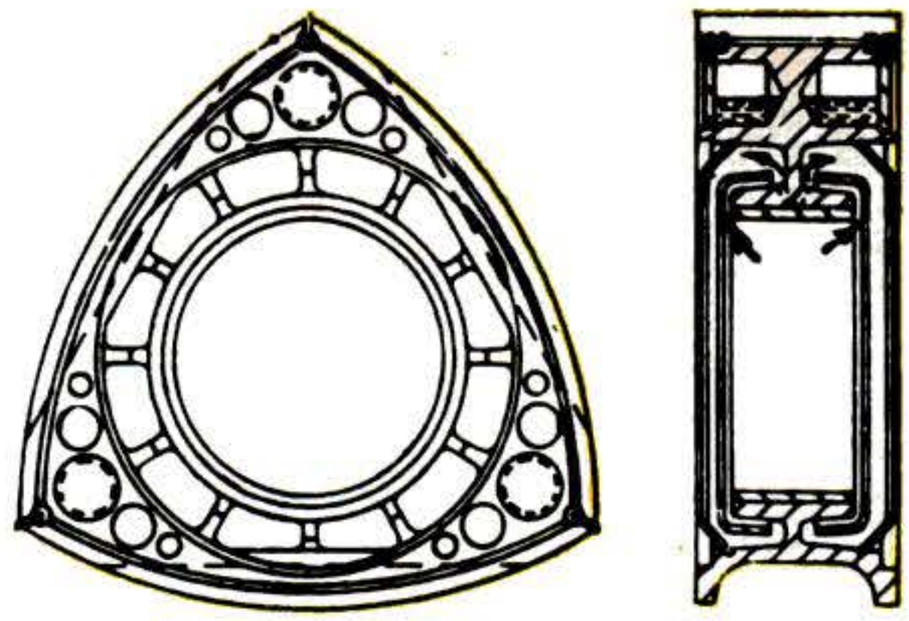
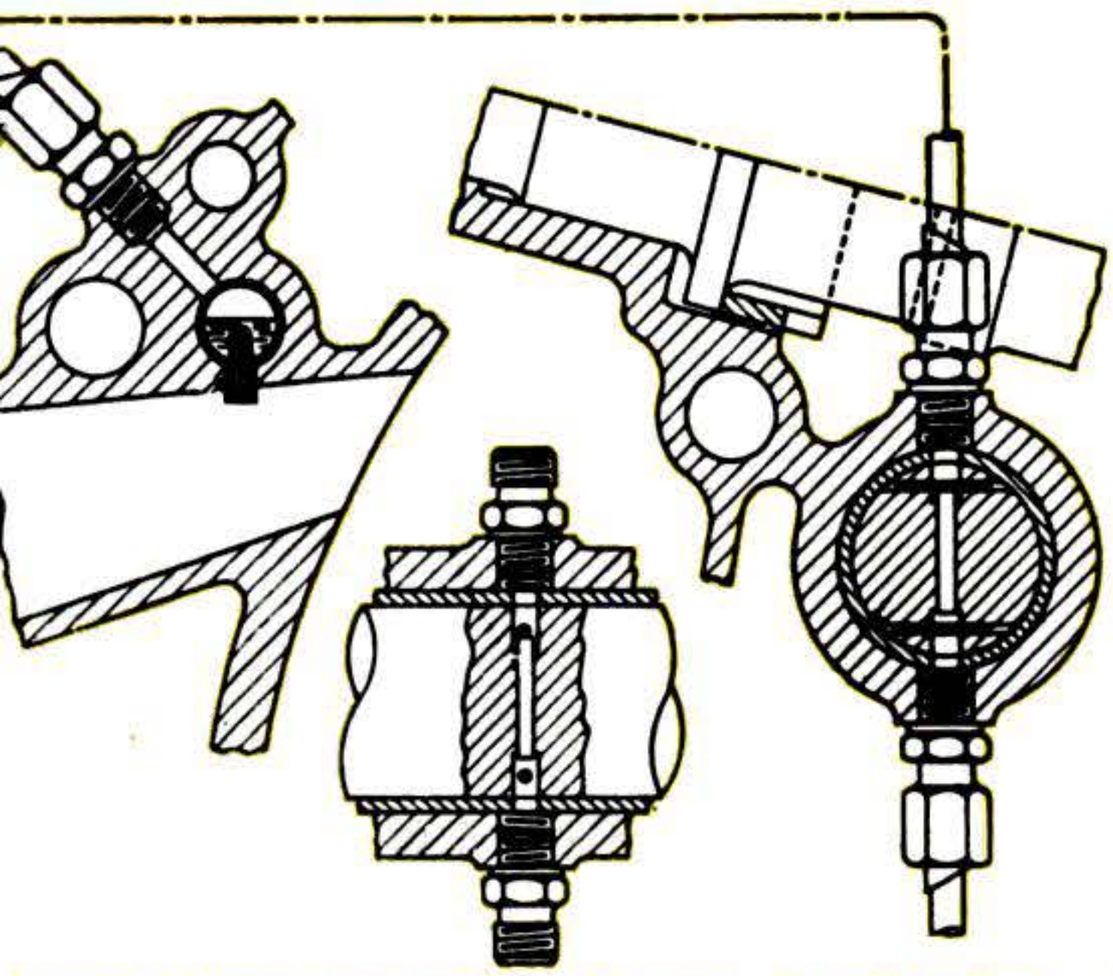


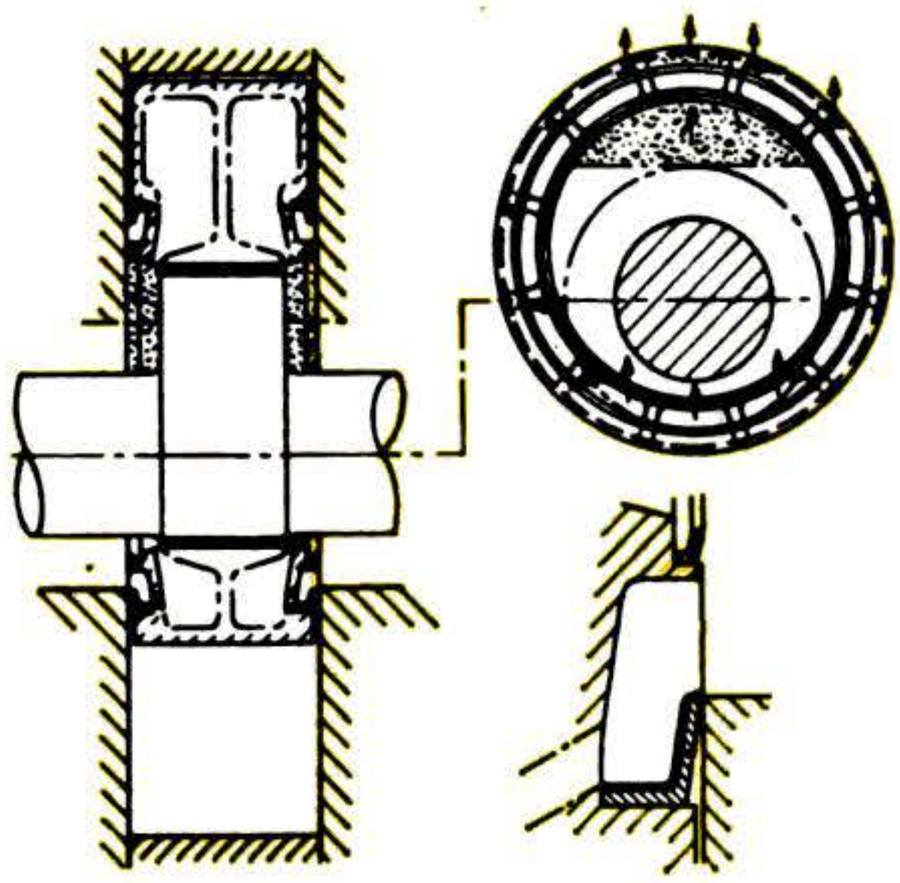
Two-stage spring-loading of apex seals was patented by Goetze. Spring shapes assure highest stability, even with nonradial seal strip angles. Carrier-mounted seals can be made thinner, more flexible.



Oil-cooled rotor has apex cavities blanked off and filled with sodium. Effects of centrifugal force can play havoc with oil circulation if unchecked, so rotor center is surrounded by a system of baffles.



Mercedes-Benz explored costly ways of lubricating the seals before self-lubricating materials became available. This system has oil injection to a metal-and-fabric wick that projects into the intake port.



Special oil seals keep combustion spaces free of oil intrusions from rotor interior, despite the flow of cooling oil and necessity of lubricating the rotor bearings. Latest seals work as one-way valves.

each chamber is smaller, and exhaust emissions are reduced.

The first three-rotor units delivered only about 200 horsepower, but improvements in sealing and lubrication soon led to an increase in power output. Slow and relentless studies of the combustion process led to further progress.

A unique Wankel. There are enormous differences between the C-111 engine and the NSU Ro-80 [PS, Sept. '67] for instance. First of all, the C-111 has direct fuel injection. Mercedes-Benz, which began production of gasoline-injection aircraft engines in 1934, never even considered using carburetors on the Wankel.

By precise metering of the fuel quantity injected, more complete combustion is achieved. Many years of experimentation with spark-plug and injector-nozzle positions have paid off toward the same goal. The nozzle type is a result of careful development work, taking advantage of the stratified-charge capability of the moving combustion chamber and its ever-changing shape. Rotor-face profiles were developed to make the most of the fact that flame propagation takes place only in the direction of rotor travel.

But exhaust emissions were not the worst problems the Mercedes-Benz engineers were faced with. The tough ones centered on seal-tip wear, effective sealing, lubrication, and rotor cooling.

When Mercedes-Benz started Wankel-engine experiments, apex seals didn't last more than about 500 hours. Forming the edges of the combustion chambers, they are difficult to lubricate. A solution, pat-

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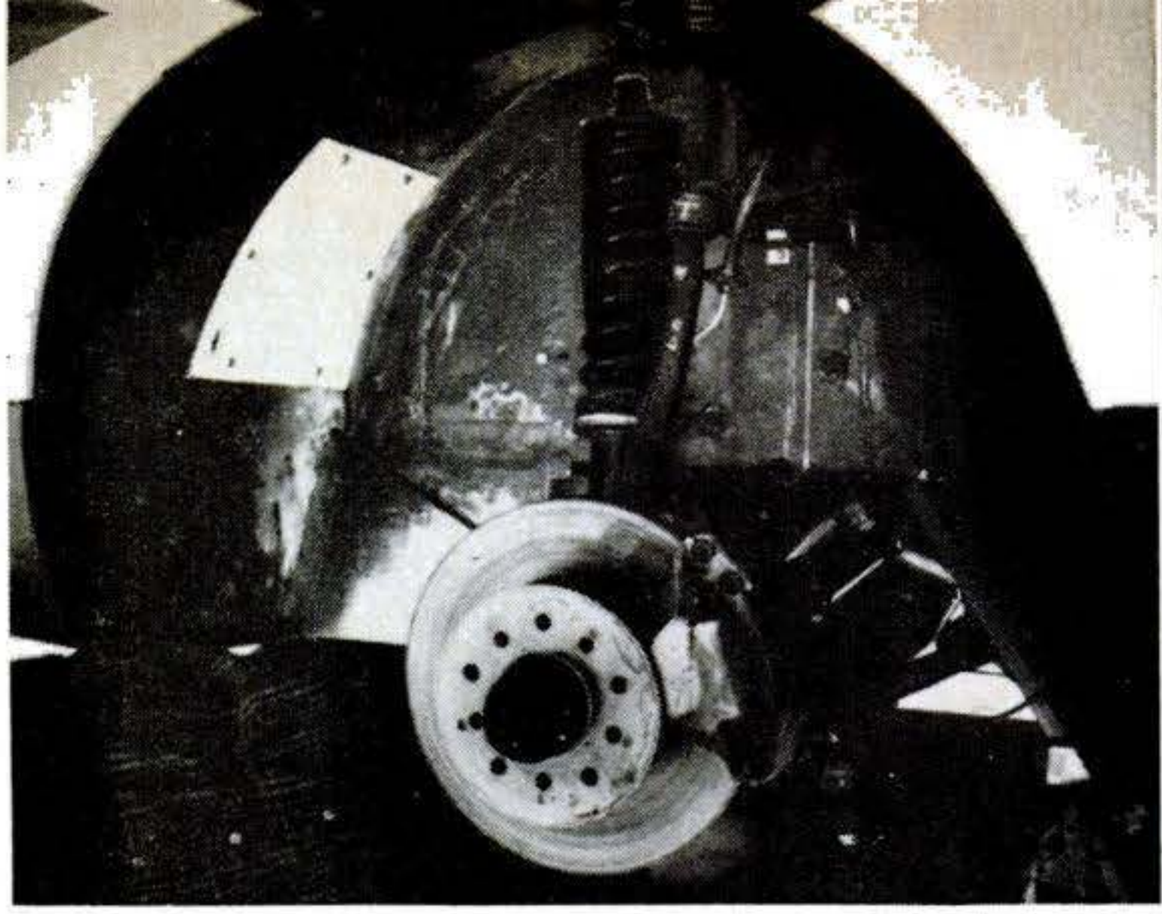
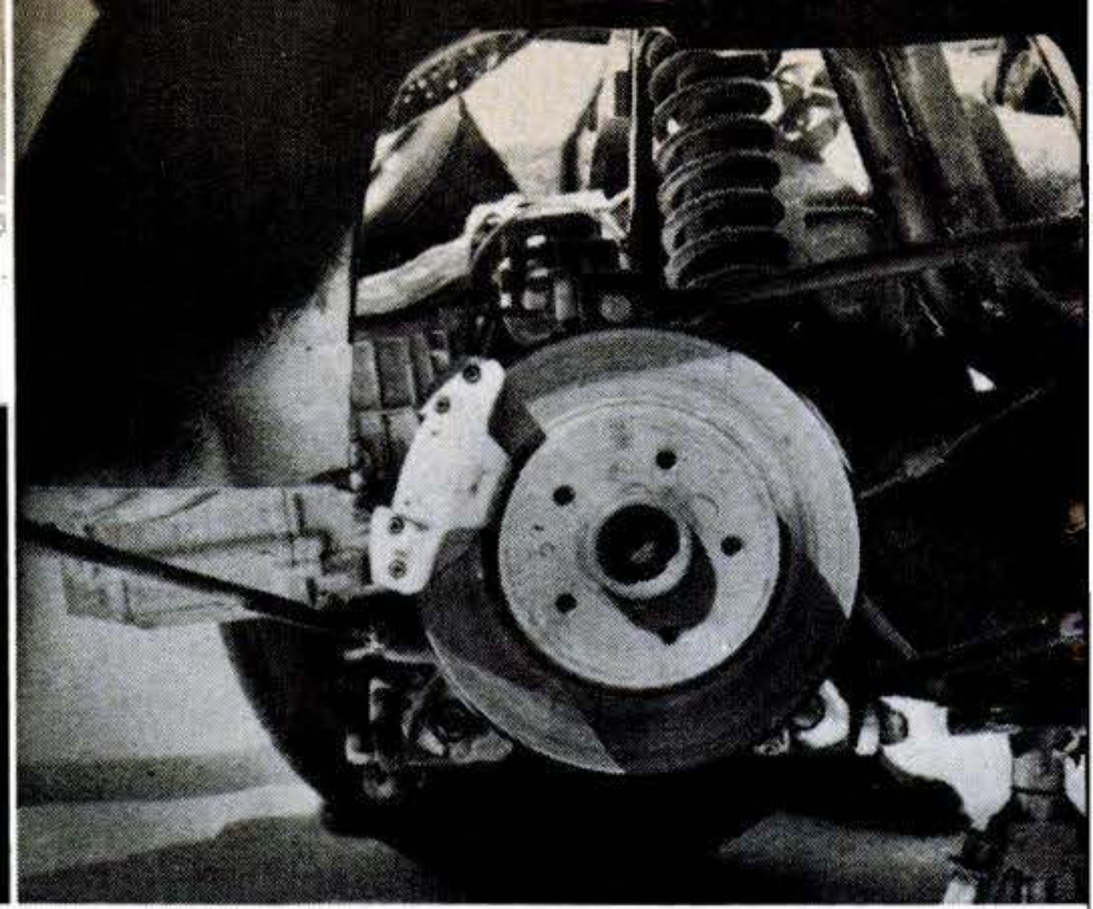


Disk brakes are used on all four wheels (of course). MacPherson front-suspension system is also favored by Porsche, BMW, VW, Fiat, Ford of Cologne.



Jewel-like machinery of transaxle and rear suspension provides proper setting for disk brake and caliper. Dry weight of car is less than 2,000 pounds.

ented by Mercedes-Benz in 1964, consists of continuous mixing of precisely metered quantities of oil with the incoming air (see drawing). The actual mixing was done by a metal-and-fabric wick projecting into the intake port, fed with oil from a metering unit with a variable-stroke plunger. It was an expensive solution. Around 1966, seals of self-lubricating materials came along. The oil wick was then put back on the shelf.

Cooling it. The water-cooling system for the Wankel engine is no more complicated than that of a piston engine. But the rotors require their own cooling system (because of the three rotor faces and high r.p.m. range, they're subject to many more ignitions per minute than pistons in a four-stroke engine). Water circulation to the rotors is almost unthinkable, and air cooling out of the question. The answer is oil cooling (as practiced by NSU, Toyo Kogyo, and also by Curtiss-Wright).

The same oil that cools the rotor is used for rotor bearing lubrication. In early tests, Mercedes-Benz found that agitation of the oil within the rotor resulted in foaming—undesirable because it reduces the oil's cooling effect.

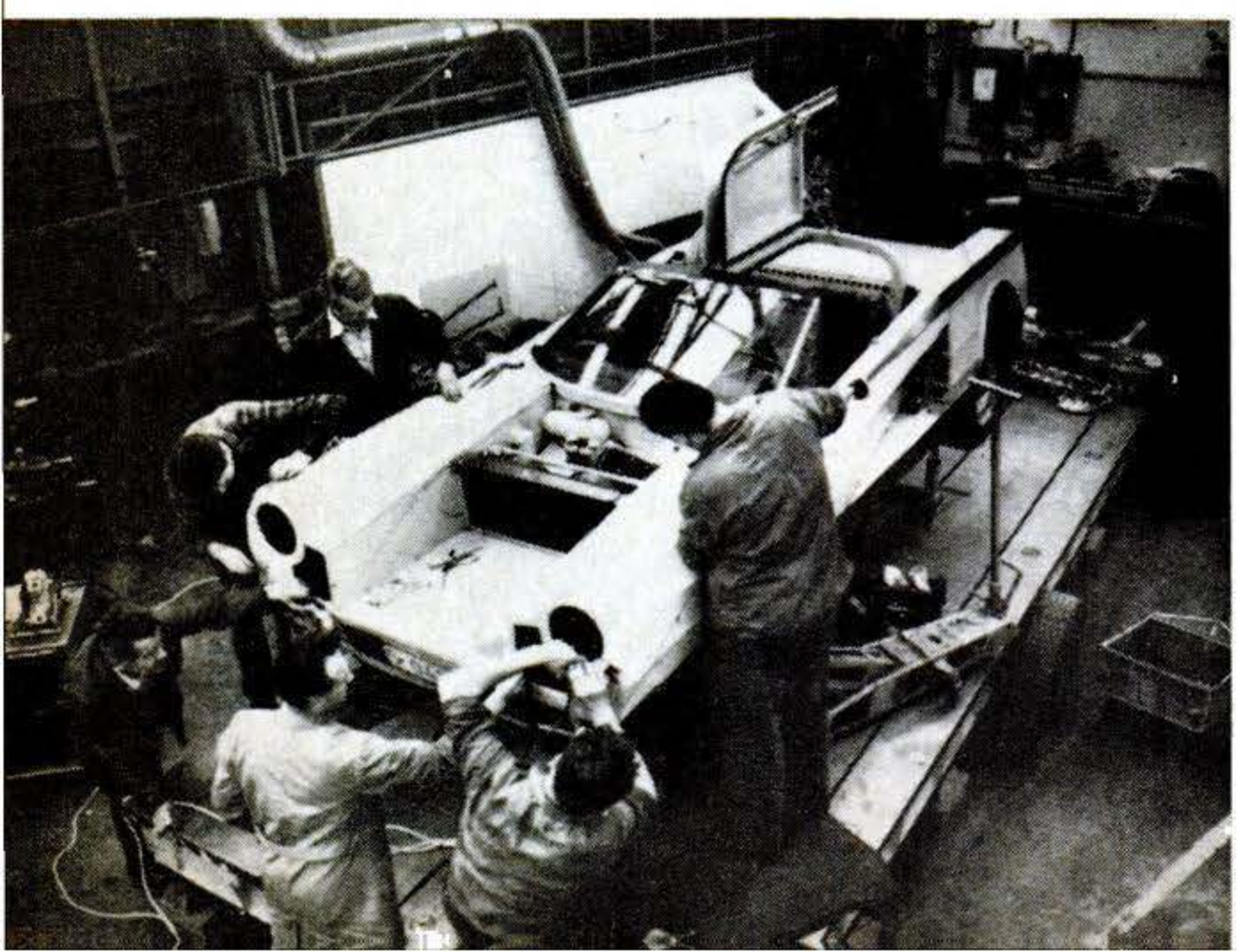
It was also found that some of the oil, particularly in the apex cavities, did not circulate and thus was incapable of providing the intended cooling. The solution was to blank off the apex cavities from the oil-circulation system and instead fill them with sodium—a high-conductivity material long used in the exhaust valve stems of Mercedes-Benz piston engines to increase heat dissipation.

Since Mercedes-Benz chose plain bearings rather than ball or roller bearings for the output shaft, bearing lubrication is highly critical. An ample recirculatory oil supply under pressure would be ideal, but excess oil tends to leak through to the combustion chamber. Mercedes-Benz has found a solution in the form of a one-way seal (see drawing) completely oil-filled.

The one-way seal. Seals are fitted on both sides of the eccentrics that act as rotor bearings. The seal has an inner ring and an outer ring. The oil that passes the inner one is then contained in a chamber formed by radial ribs between the two seals. The ribs have a slight clearance from the resilient lip of the outer ring. This lip extends radially inward and effectively prevents the oil from escaping into the combustion space, while staying at surface level and providing lubrication where needed.

In developing new types of seals, Mercedes worked closely with Goetze Werke,

C-111 prototype under construction shows roof-hinged doors, recalling famous gull-wing 300 SL. Ducts in body sides feed engine, help cool brakes.



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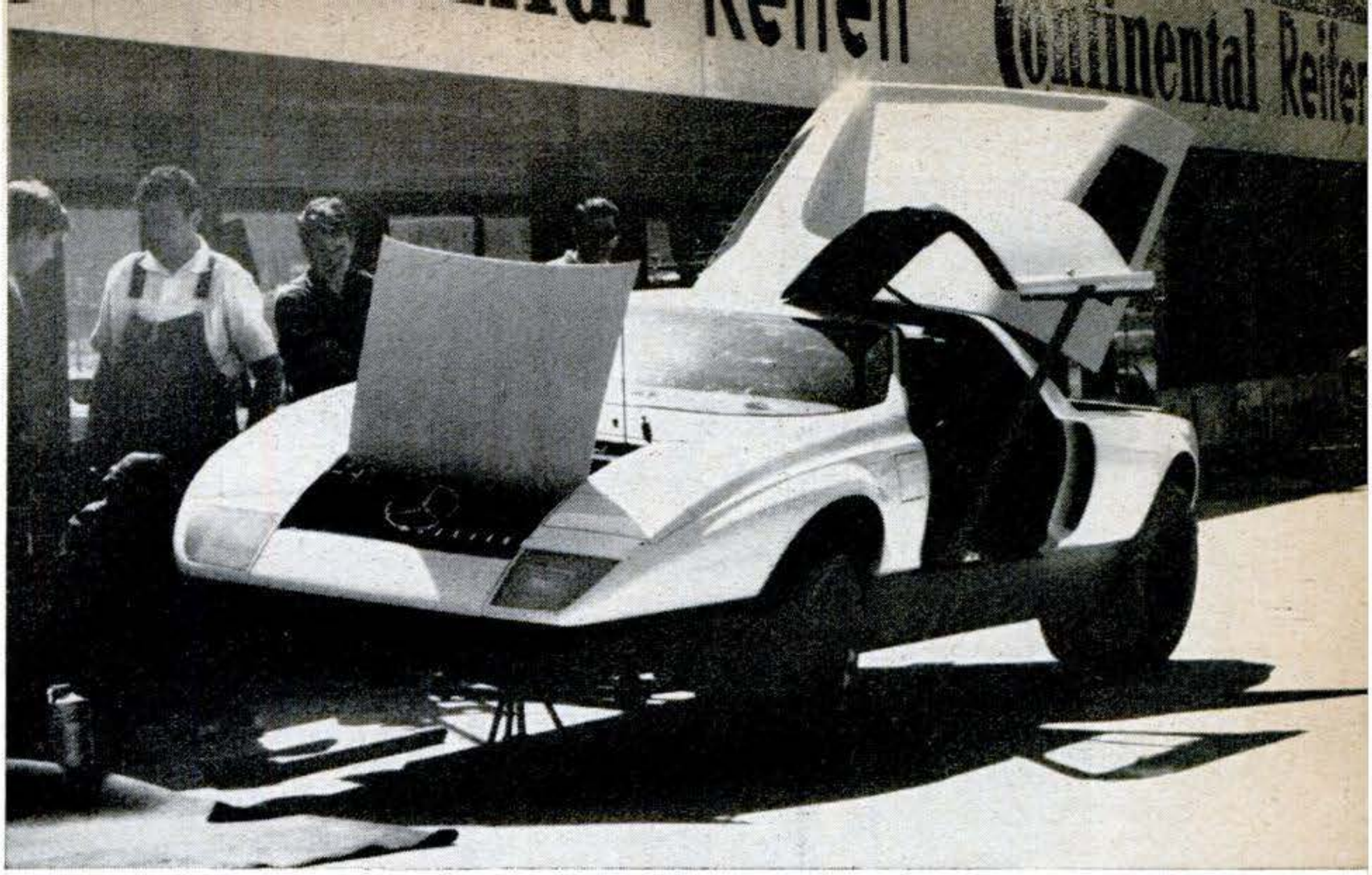

Tire and performance tests with pre-production prototypes were conducted at Hockenheim race circuit in Germany. While brake pads are changed, mechanics also change spark plugs and check master-cylinder reservoir, oil, and water under front hood. Before C-111 chassis was ready for test work, the three-rotor Wankel engine logged hundreds of thousands of miles in ordinary-looking 300 SE Mercedes sedans. Both radial-ply road tires and special racing tires were used during testing.

which began to take out patents in its own name in 1965. The main innovation by Goetze was the seal-strip carrier—a new part that isolates the seal from the rotor. The seal strip is spring-loaded away from the carrier, and the carrier is spring-loaded away from its groove in the rotor (see drawing). The carrier made possible the use of slimmer, more-flexible seal strips. Spring-loading permitted more-effective sealing regardless of engine temperature.

And the car itself? The C-111 is an addition to the line, and does not replace the 280-SL. It's a different kind of car—in the tradition of the fabulous 300-SLs (made from 1954 to '62).

The C-111 chassis has no parts common to any other Mercedes car. It was designed as a separate model from the ground up, and uses different suspension systems (see photos). The front suspension is of the MacPherson type, and the independent rear suspension resembles that used on the Ford GT-40.

The midships engine position gives a weight distribution that tends to produce ideal handling characteristics for a high-performance car. Concentrating the mass near the center of the car gives a low polar moment of inertia, which tends to give the car neutral steering. Elimination of the propeller shaft makes for savings in both space and weight.

Is Mercedes going racing again? Definitely not. This is a high-performance road car, and a direct competitor to such exotic machinery as the Ferrari 275 GTB/4, Maserati Ghibli, and Lamborghini Miura, but it's not intended as a racing car. The price will also be comparable—around $15,000 to $18,000. Some people in Detroit might be willing to pay that for the engine alone. PS

Near-vertical banking on Mercedes-Benz's own test track in Stuttgart allows quick turn-around between straightaways. Here, car is doing about 125 m.p.h.

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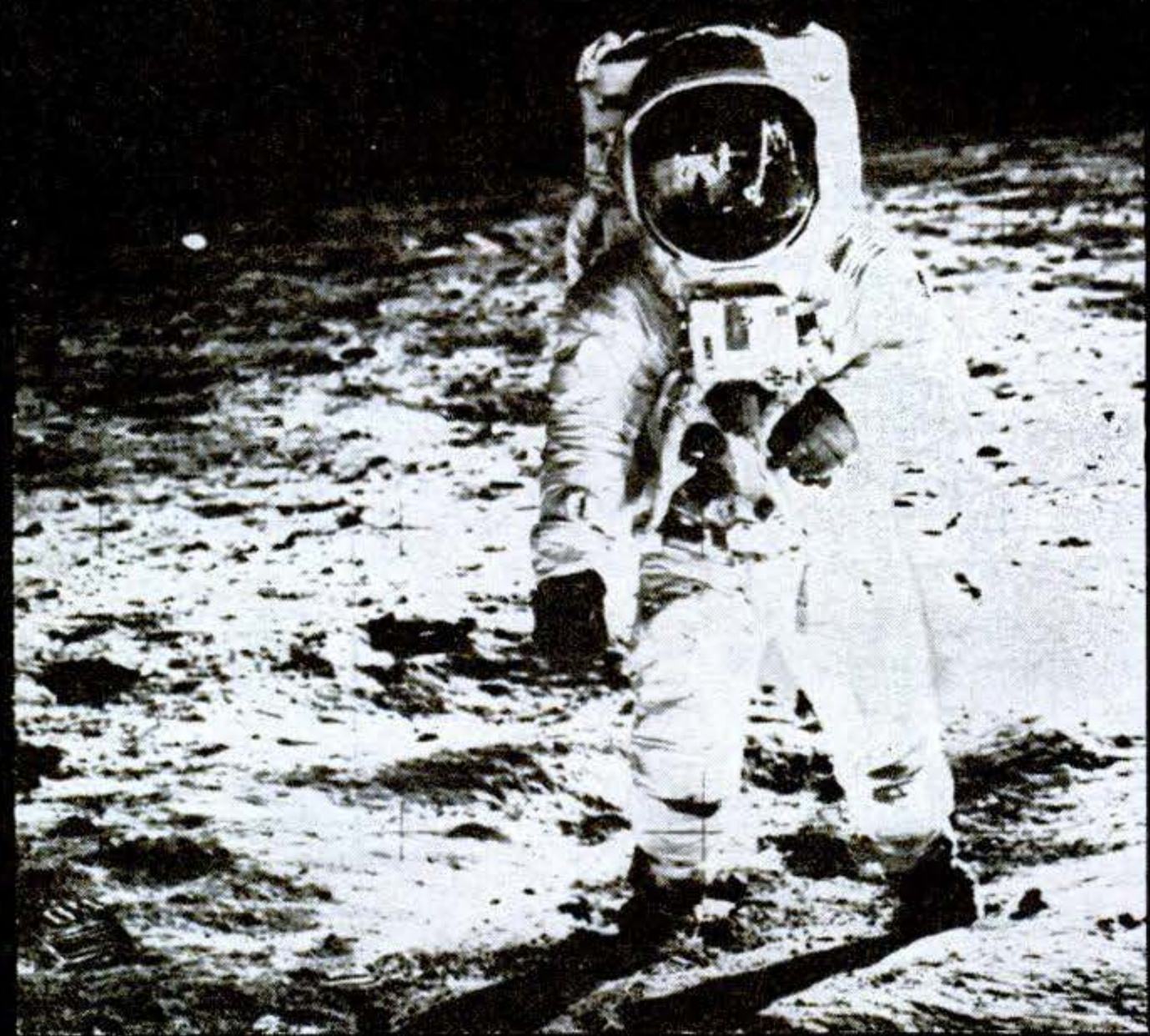
WHY WE'RE GOING BACK TO THE MOON

By DR. WERNHER VON BRAUN

Director of NASA's George C. Marshall Space Flight Center, Huntsville, Ala.



First moon-walkers—Aldrin, and Armstrong (mirrored in Aldrin's visor), at Tranquillity Base—have pioneered way for next lunar landings.

In daring Apollo landings soon to come, many more lunar explorers will follow our first ones—and here a famous space expert gives you a preview of the rewards they'll seek to gain for us

Next month Apollo 12 will head for the moon and a touchdown in the Ocean of Storms. It is the first of up to nine lunar-landing missions, between now and the summer of 1972, planned by NASA to follow up the dazzling success of Apollo 11's pioneers on the moon.

Why are we going back? What more do we hope to learn? First, the moon is a big place—its near side, alone, twice as big as the United States. So far we have landed on one mare—selected for lack of obstacles and ease of approach, with scientific interest strictly taking a back seat. To think that now we know and understand the moon would be like landing in the Mojave Desert and saying that now we know all about the geology and geography of North America.

Still-unexplored reaches hold mysteries of the moon that scientists can hope to solve at last. And probing the moon for

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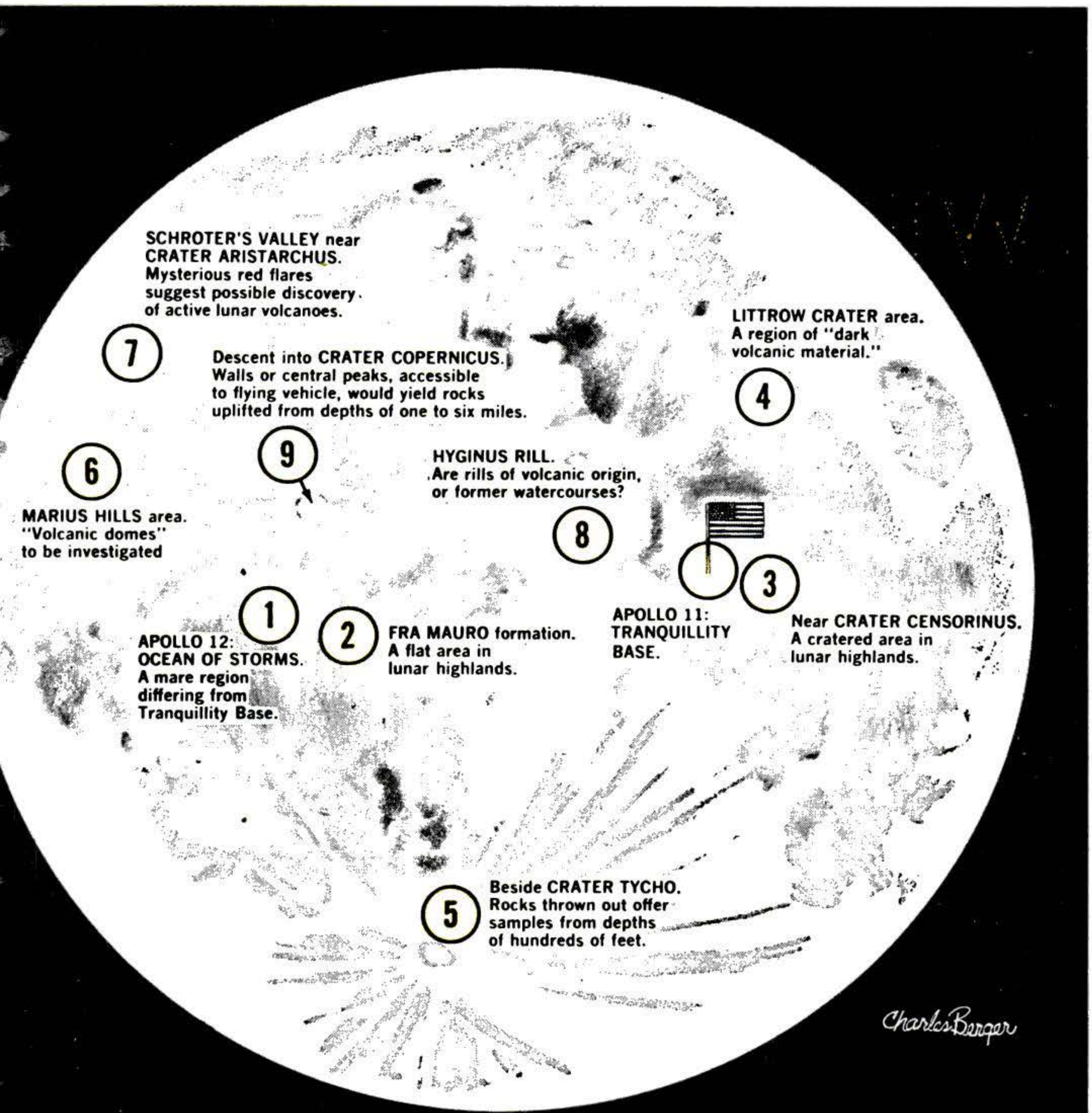

Sites proposed for next moon landings are these numbered ones, beginning next month with Apollo 12 in Ocean of Storms (1), and reaching climax with descent into majestic crater Copernicus (9). Ranging afar from landing spot of Apollo 11 (flag), sites are all on moon's near side. Far-side landings will await a radio link with earth, perhaps via future lunar relay satellites.

esources of practical value promises rich ewards.

To the moon at bargain cost. There is a urther incentive for mounting more expeditions to the moon right now: We shall never again be able to do it so economically. This is the reason:

When, in 1961, President Kennedy announced a moon landing in this decade as national objective, we in NASA had to decide how many space vehicles to build. Going by the state of the art of rocketry at that time, we expected to have to fly eight to 10 Saturn Vs unmanned, before we could see our way clear to man the supersize rockets. We judged that we might attempt the first lunar landing with the 13th or 14th Saturn V. So 15 of the great Saturn V rockets were actually authorized and built.

Likewise, our spacecraft associates fig-

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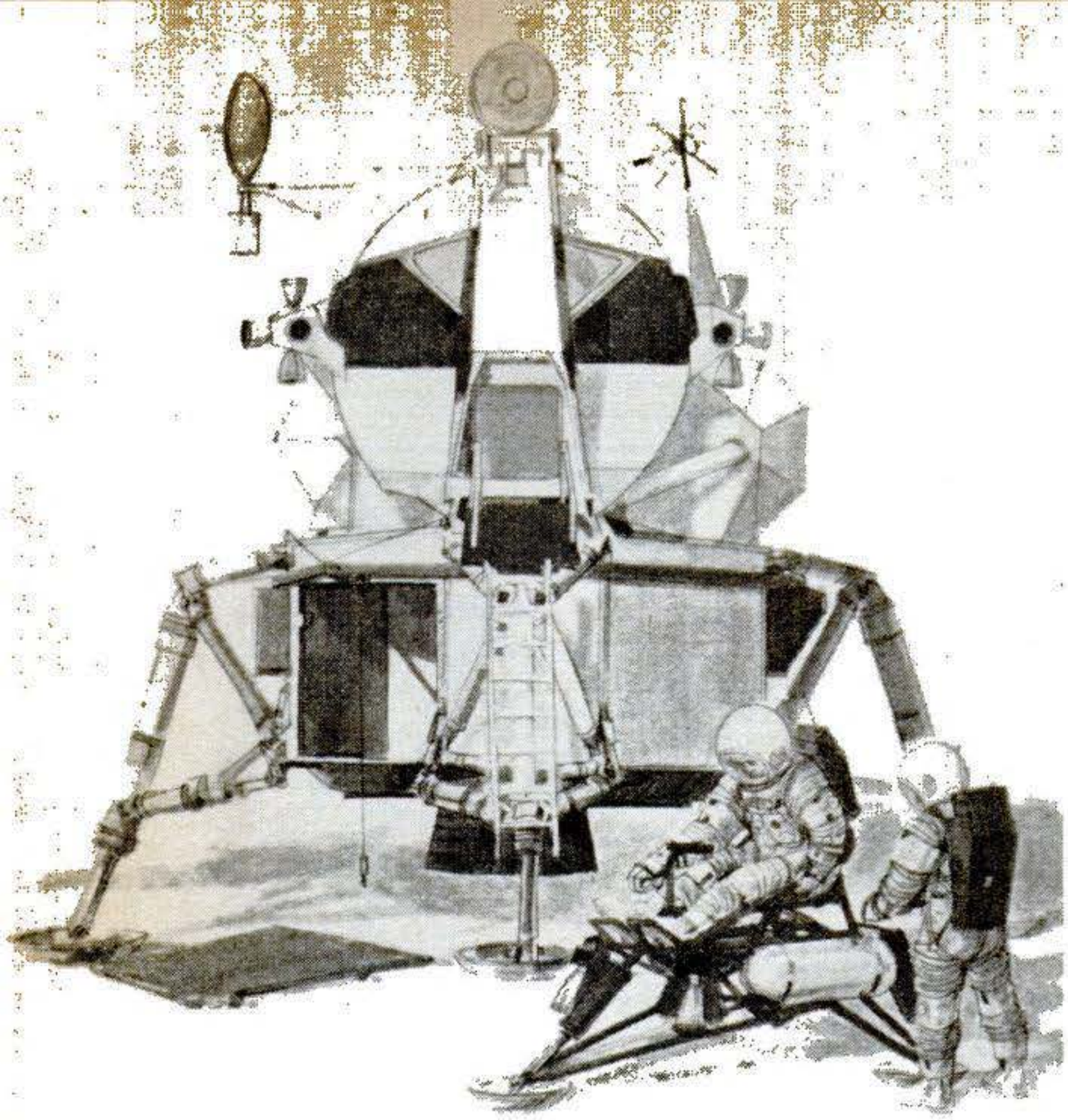
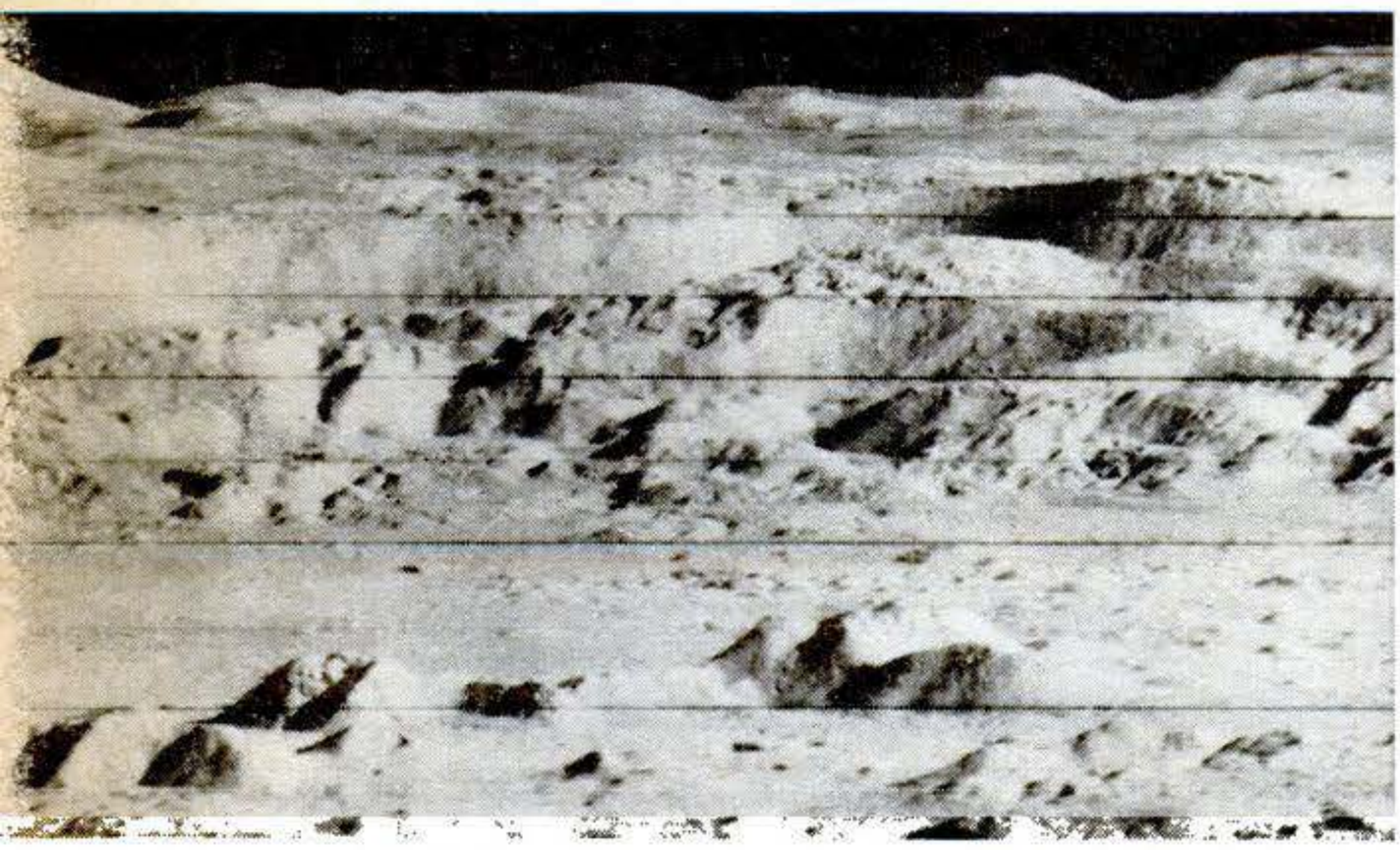


"Augmented" Lunar Module will look outwardly like present one, Grumman drawing shows, but bigger payload can include surface "rover" or pictured flying vehicle—which would be needed at scene below.



Coming landings' boldest target is bottom of two-mile-deep crater Copernicus—viewed in Lunar Orbiter photo that has been called "picture of the century."

Touchdown just outside crater Tycho, pictured in Lunar Orbiter photo, would get samples of moon from hundreds of feet deep by gathering thrown-out rocks.

ured on many orbital tests of Apollo spacecraft modules, before we would dare put an Apollo on top of a Saturn V—let alone fly it to the moon.

As it turned out, only two Saturn Vs needed to be flown unmanned. The third one launched the memorable Christmas '68 voyage of Frank Borman and his Apollo 8 crew around the moon. With the fourth and fifth, Jim McDivitt's Apollo 9 flight accomplished the difficult spacecraft maneuvers in earth orbit and Tom Stafford's Apollo 10 mission performed them in lunar orbit. Thus it was the sixth Saturn V that Neil Armstrong's Apollo 11 rode to the lunar landing.

This means that NASA now has a sizable fleet of Saturn V/Apollo space vehicles left over, all designed and built to fly to the moon—and all completely paid for by the American taxpayer. We have the competent industrial and government teams to put them to use, and the well-trained and dedicated astronauts ready and eager to fly them.

NASA turned to the National Academy of Sciences for an independent judgment on the value of a program to continue lunar landings with this remaining Saturn V/Apollo fleet. It will be scientifically worthwhile, the Academy replied after careful study, provided more scientific gear can be landed on the moon; the astronauts' stay time can be extended from one to three days; and sites of particular scientific interest are selected.

Reaching these sites will call for pinpoint landings in difficult topography, and for ability to travel on the lunar surface—as in a roving vehicle that astronauts can drive 10 or 15 miles—to places unsuited for landings.

A new moon-landing craft. Key to all of this was a Lunar Module that could land more weight on the moon. The extra payload could be allotted to consumables for a longer stay, the roving vehicle, more scientific gear, extended hovering, or a combination of some of them.

The present Lunar Module's maker, Grumman Aerospace Corp., was asked to study these requirements, and produced a plan for an Augmented Lunar Module that has, in essence, enlarged descent-stage tanks. As these carry extra propellants, the total launch weight of the Lunar Module increased from 33,000 to 34,250

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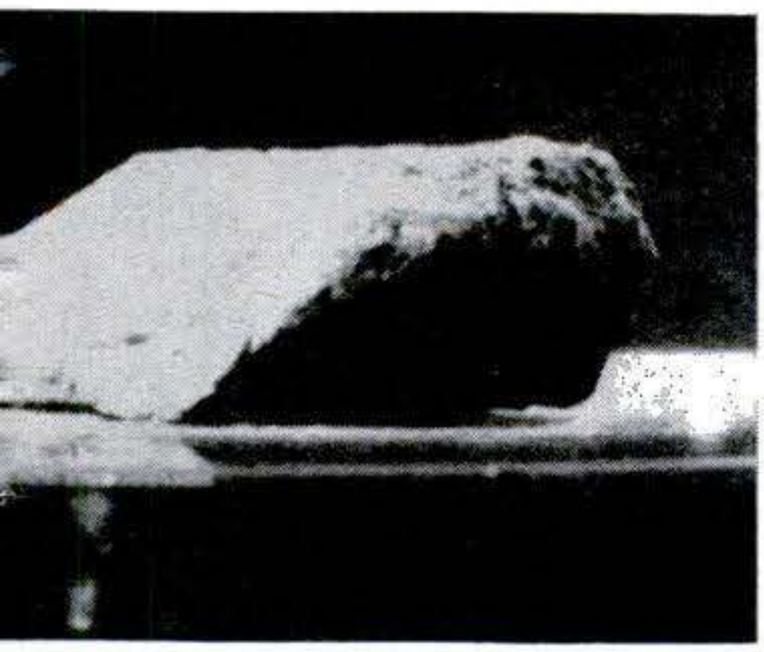


First moon rocks arrive on earth! Security man shoos photographer aside, right, as Houston lab receives box containing part of Apollo 11's 54 pounds of lunar samples—"worth more than all the gold in Fort Knox," according to NASA's head, Dr. Thomas O. Paine. One of first specimens examined, the three-inch rock above, is called igneous (once-molten) and has glass-lined pits, possibly from impact of micrometeorites. Moon samples are due to go to 142 investigators and their associates for what may well be the most intensive study that any mineral specimens have ever received.

pounds. The added weight, of course, had to be boosted toward the moon by the Saturn V—but it turned out that if the big rocket flexed its muscles just a bit more, it could handle that extra load.

As of this writing, design work on the Augmented Lunar Module (ALM) is almost completed. And nearly 20 companies have prepared competitive proposals for the lunar-roving vehicle.

Meanwhile, a special team has selected a series of proposed landing sites, shown on an accompanying moon chart, for the follow-on missions. They form a moon itinerary to make a scientist tingle with anticipation:

Program for moon explorers. Even the earliest landing sites, still in relatively easy terrain, will contrast with Apollo 11's Tranquillity Base—the first, in the Ocean of Storms, being a mare area of different characteristics.

Then, when the ALM comes along, will follow more-difficult touchdowns at sites of keenest interest:

Are meandering lunar features, called rills, former watercourses or collapsed lava tubes? Inspecting these and other telltale features may settle the controversial question of the role of volcanoes in the moon's history.

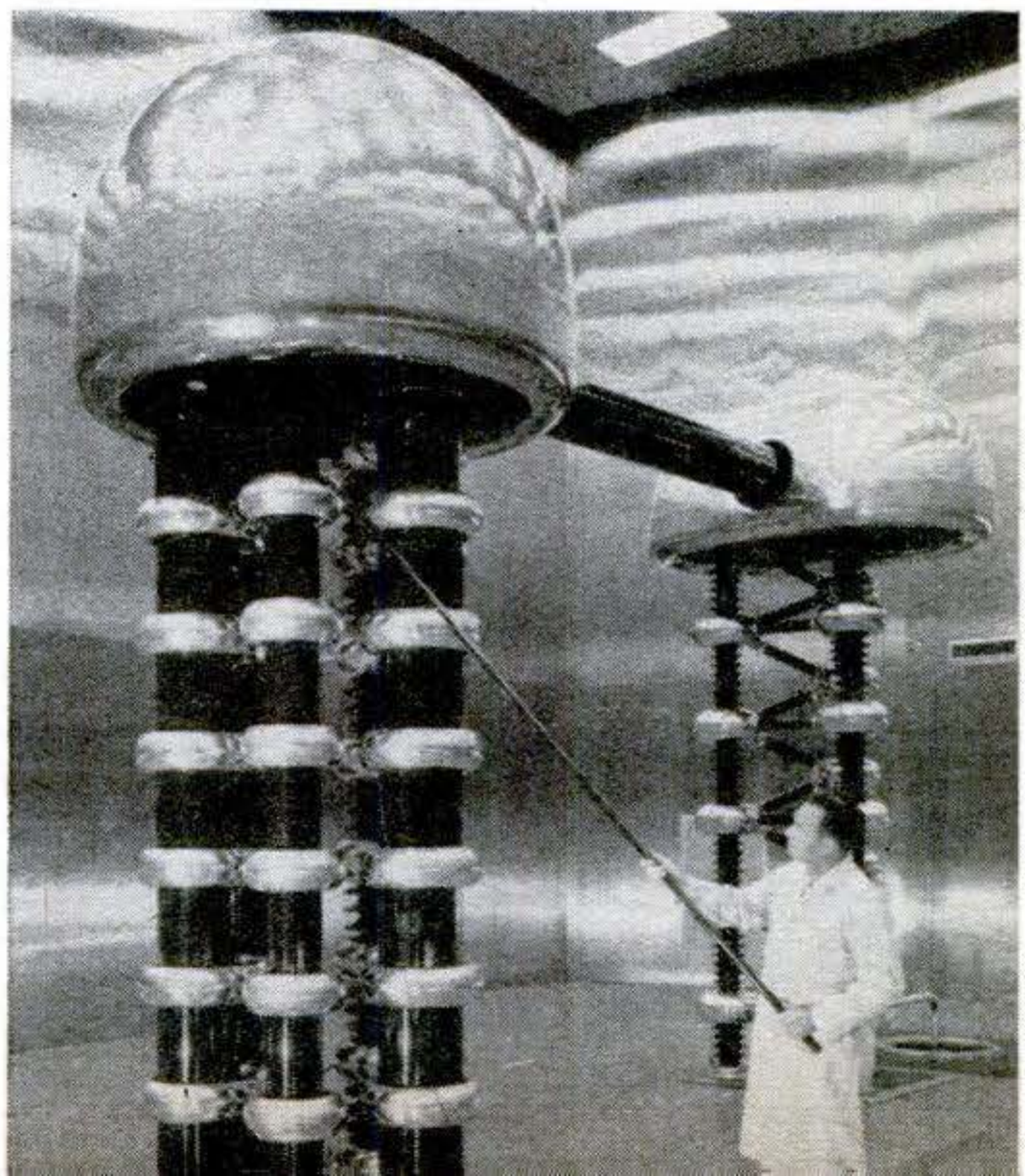
A projected landing at Schroter's Valley near the crater Aristarchus may even make the sensational discovery of still-active lunar volcanoes. Mysterious red flares sighted here have been variously ascribed to a glow called thermoluminescence, or to volcanic action.

Rocks thrown out when the yawning crater Tycho was formed, and collected by landing just outside it, should reveal the composition of the moon's crust to a depth of several hundred feet.

Climax of the program is to be a daring descent to the bottom of the majestic crater Copernicus, "monarch of the moon"—two miles deep, 60 miles across. Its walls and central peaks promise samples of

[Continued on page 218]

Giant 1,000,000-volt electron microscope, biggest in country, is readied to wrest secrets from moon rocks at U.S. Steel lab at Monroeville, Pa. It will peer all the way through specially thinned specimens.



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THUNDERBOLT MACHINE Test

Man-made lightning of five million volts flashes from thunderbolt machi to grounded pole in a spectacular night demonstration. View at left sho inside of the 75-foot-high generator, looking straight up from botto

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With 5,000,000-volt fireworks at amazing outdoor proving ground, engineers duplicate natural lightning, switching surges, and even effects of nuclear bombs

Tomorrow's Power Lines

By W. STEVENSON BACON

It looks like a scene in a science-fiction movie. A 75-foot-tall machine hurls 40-foot lightning bolts, and duplicates the electromagnetic radiation of a nuclear explosion. Resembling creatures from outer space, three huge high-voltage transformers on long legs are linked by pipe "arms" and crowned with spherical heads. When researchers take safe refuge in a control building and energize this eerie laboratory, great electric arcs leap and play between a power-transmission line and a 100-foot-high test tower.

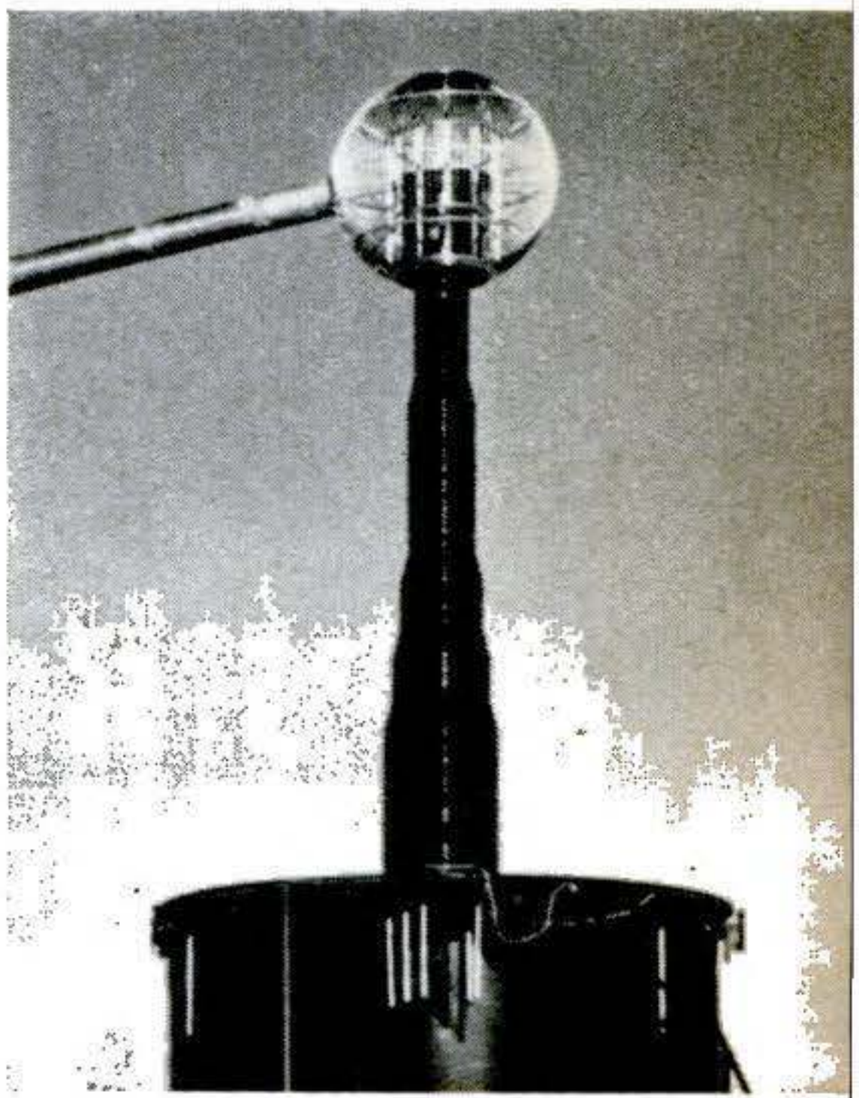
This is the new outdoor proving ground of General Electric's Ultra High Voltage Laboratory at Pittsfield, Mass., in the foothills of the beautiful Berkshires. Its amazing machines test the immense towers, insulators, and conductors of transmission lines to carry power at the ever-higher voltages of tomorrow. To try them out in all kinds of weather, the apparatus has to be out in the open.

Lightning made to order. Central feature of the weird array of equipment is the six-story-high "thunderbolt machine." Engineers call it an impulse generator. Others have been built by GE before—and have produced artificial lightning of even higher voltage and longer arcs—but this one is unique:

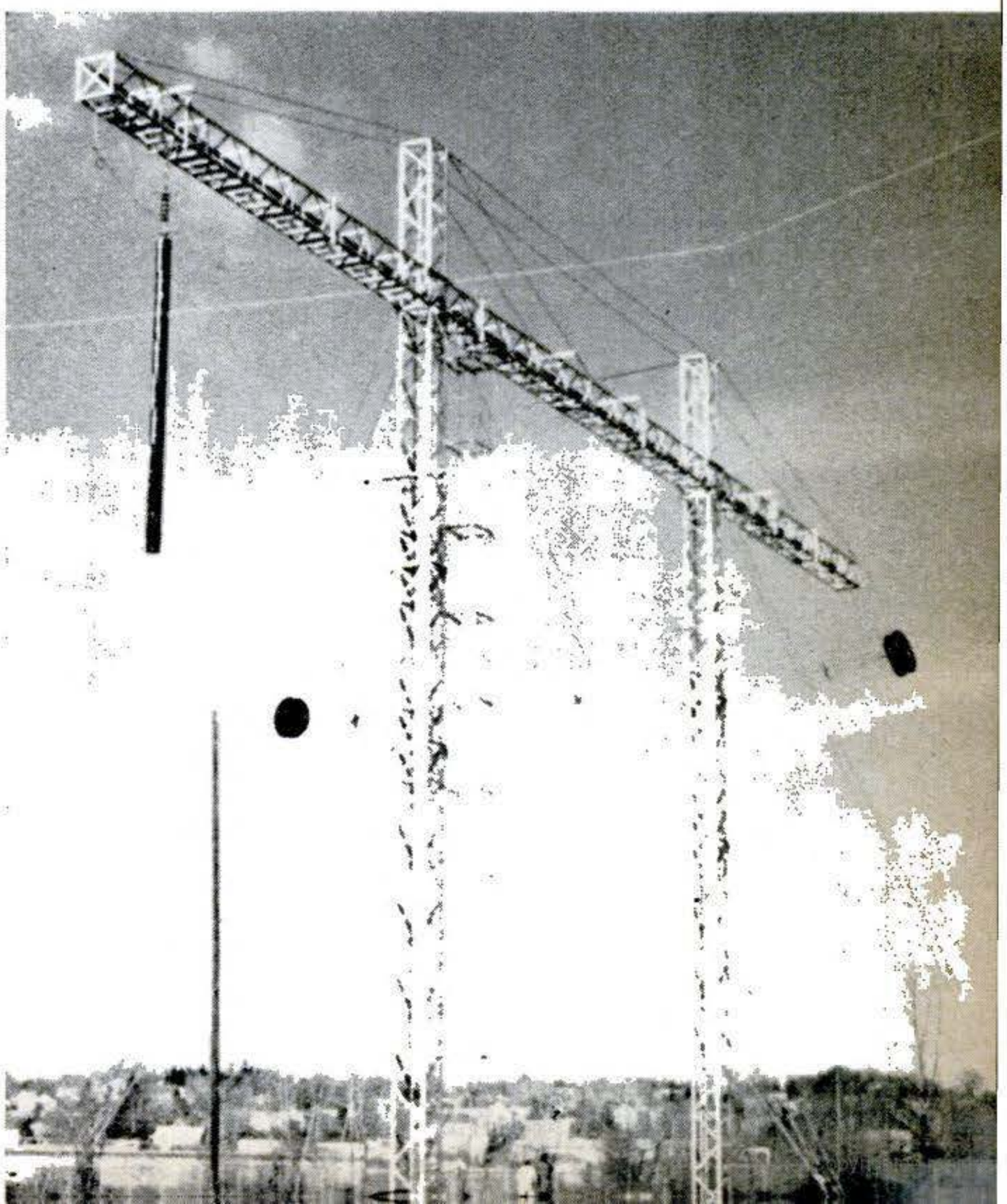
It is the first designed for all-weather use, outdoors. Sealed from the elements in plastic housing, it makes its own weather inside, with a system that forces dry air up through the central shaft. It simulates not only natural lightning, but the even more stressful high-voltage effects that power engineers call switching surges. And it is the only machine of its kind with a built-in passenger elevator—which travels on fiberglass rails to avoid drawing hot arcs from the circuitry.

Continued

Biggest in world, 39-foot-tall transformer bushing, rising from tank of insulating oil and topped by a corona-shield sphere, is one of the eye-filling pieces of equipment for a 1½-million-volt power line recently tested at outdoor proving ground. It weighs 12 tons.



Experimental power line for 1½ million volts hangs from 100-foot-high test tower with two legs 80 feet apart. When thunderbolt machine zaps line, fiery arcs leap between conductors and tower—until increasing the spacing between them provides enough clearance.

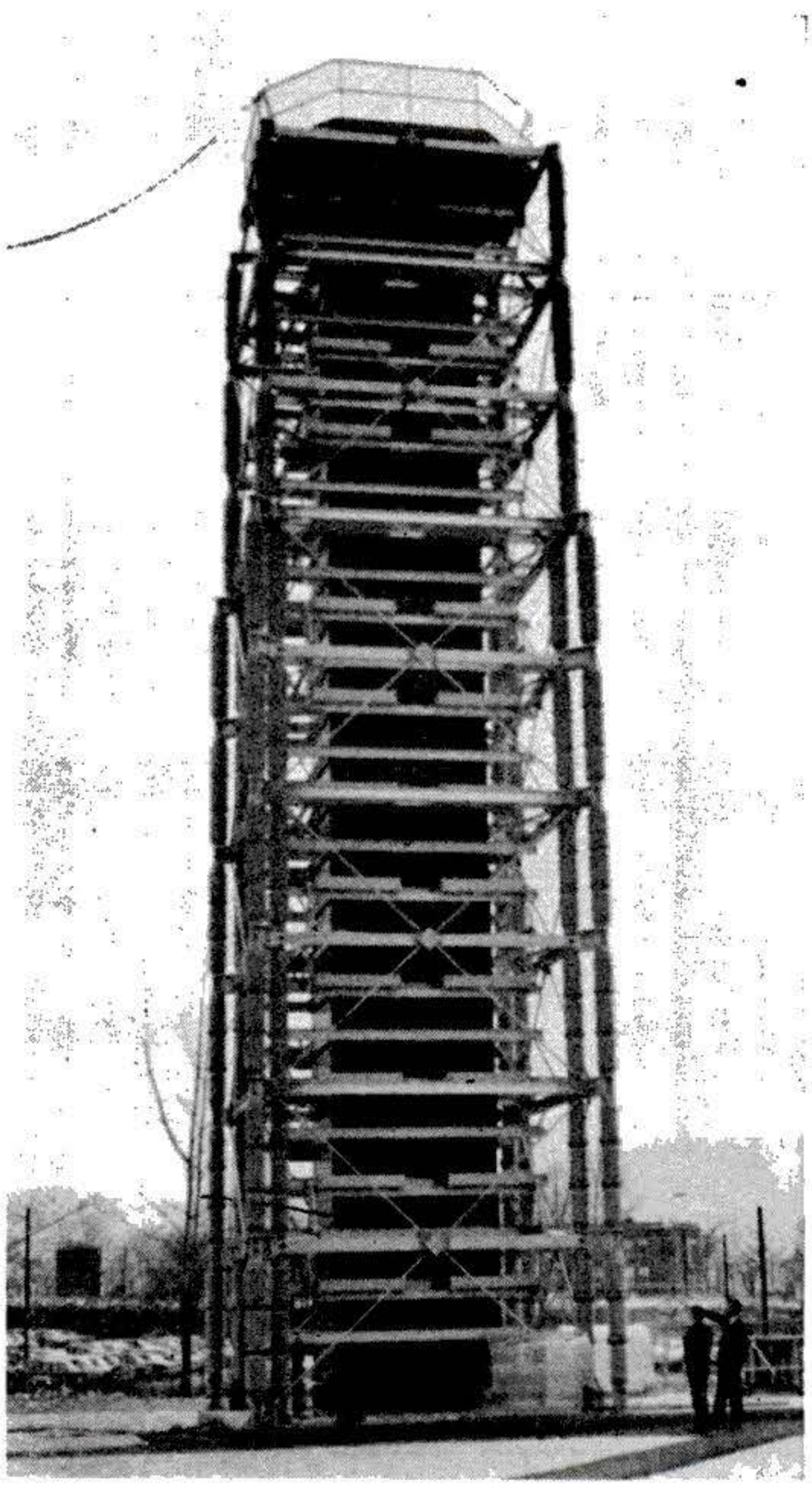


"Space-creature" transformers feed a trial line with current at

Walking downstairs into its "basement," I craned my neck and could look straight up to the top—75 feet of polished 10-inch copper spheres, bright-red resistors, capacitor bushings, and thick bus bars to connect everything together.

In action, the fantastic-looking machine operates by remote control. Experimenters watch a meter needle on a control console rise toward 200,000 volts, over a 30-second period, as the machine's 25 banks of capacitors are charged from two 100,000-volt power sources in its base. The capacitor banks are connected in parallel during this charging period.

To fire the generator, the operator presses a button. What happens amounts to reconnecting the capacitor banks in series—boosting the maximum voltage to 200,000 multiplied by 25 capacitor banks or five million volts. Inside the generator a small increment of voltage is added to the first capacitor bank, and an arc leaps the gap between the first two copper balls. Then, like a string of toppling dominoes each spark gap from bottom to top fires in turn, unleashing the thunderbolt. There is a loud report as a lightning flash leaps to ground—by way of an experimental power line conductor and its tower, or some other piece of equipment to be tested.



Awesome size of outdoor impulse generator is shown by comparison with two spectators standing at right of its base. Plans for ultimate capacity of 7.2 million volts would boost its height 40 feet more.

"Eventually we may expand to 7.2 million volts," I was told by one of my hosts, engineer Adolf Kachler. "The generator is built so that we can add on more capacitors." That would add 40 feet more to its present height.

More voltage to bring you more power. One major purpose of the outdoor lab and its lightning-wielder is to help design the power lines we'll be building 10 years from now. It will take ultra-high-voltage systems, engineers foresee, to supply more and more juice to run those new appliances you've been buying—and meet a demand for power that is doubling every 10 years.

Try to transmit more electric current at the power-line voltages used thus far, and you run into difficulties. Power loss from the resistance of the line increases as the square of the current—double the current, and you quadruple the power loss. Bigger and heavier conductors would be needed, until a point would be reached at which they became impossible to support on towers.

Double the *voltage*, on the other hand, and you can pump four times the power through the same-size line. That's why power-line voltages are going up, and will go higher still. By the time you read this, the first 765,000-volt power line in the U.S. will be in operation; built by American Electric Power Co., it will ultimately connect power plants in five states. Tomorrow's systems will use even higher voltages—perhaps 1,000,000, 1,250,000, or 1,500,000 volts.

Anticipating them, GE's new proving ground already is testing an experimental portion of a 1,500,000-volt system to dis-

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to 1,500,000 volts

Spherical "heads" and connecting "arms" make three 500,000-volt transformers, forming 1½-million-volt supply to test power lines of future, look like weird visitors from another world. The globes atop them—corona shields, whose rounded shape keeps high-voltage electricity from escaping—have 100-inch diameter.

cover what technical problems will arise.

Here is where those "creatures from space," a trio of specially designed 500,000-volt transformers, come in. Linked together, they feed the test line with 1½-million-volt current, at 60 cycles. For their out-of-this-world shapes, there is good reason:

The transformers' "heads" are 100-inch-diameter globes known as "corona shields." Spherical and smooth, they prevent the escape of high-voltage electricity—which leaks into the air from pointed or rough metal, in a glowing discharge called corona. For the same reason, pipes rather than wires join the transformers. A similar scheme provides corona-free ultra-high-voltage transmission lines: Several parallel cables, spaced well apart in a "bundle" or "cage," form a conductor of much larger effective diameter than a single cable, and so keep power from straying off into the surrounding air.

As voltage goes up, conductors must be hung farther apart, and with more clearance from towers—or flashovers will occur. A flashover means at least temporary loss of line operation: Your lights flicker, dim, and in severe cases go out. In preventing flashovers, designers must take into account not only a line's planned voltage, but also the added voltage that may come from lightning and lightning-like phenomena.

GE's thunderbolt machine hits the experimental 1½-million-volt line with enough extra voltage to simulate these natural and man-made surges of energy that can cause minor power disruptions or major blackouts.

Fighting man-made lightning. Actually, the big bugaboo is the kind of artificial lightning known as a switching surge. Whenever a switch or circuit breaker is operated on a transmission line—say, to interconnect distant power plants at a time of peak demand—there is a momentary surge of voltage that taxes the insulation of the whole system. Multiply the original voltage by 1.5 or 1.6, and you have a good idea of what this surge will be. A line operating at 1,500,000 volts will have to withstand surges up to 2,300,000 volts.

"A switching surge applies greater stress to a system than lightning does," engineer Kachler told me. "A lightning surge lasts only about 100 microseconds, while switching surges last anywhere from 1,000 to 3,000 microseconds. The longer the period of voltage stress on a power-transmission line, the greater the chances of a flashover."

The new outdoor generator's burst of energy can be precisely tailored to simulate lengthy switching surges as well as lightning. A precision piece of equipment, the machine can duplicate the wave form of various surges. It can be programed to repeat them, automatically, at half-minute intervals or less.

With a recycling time of just 30 seconds at five million volts, the generator can be set to produce bolt after bolt of lightning—or one flashover after another from simulated switching surges. Tests can be made at any preset voltage. The amount of energy the generator can store, 250 kilowatt seconds, is probably close to a record.

[Continued on page 228]

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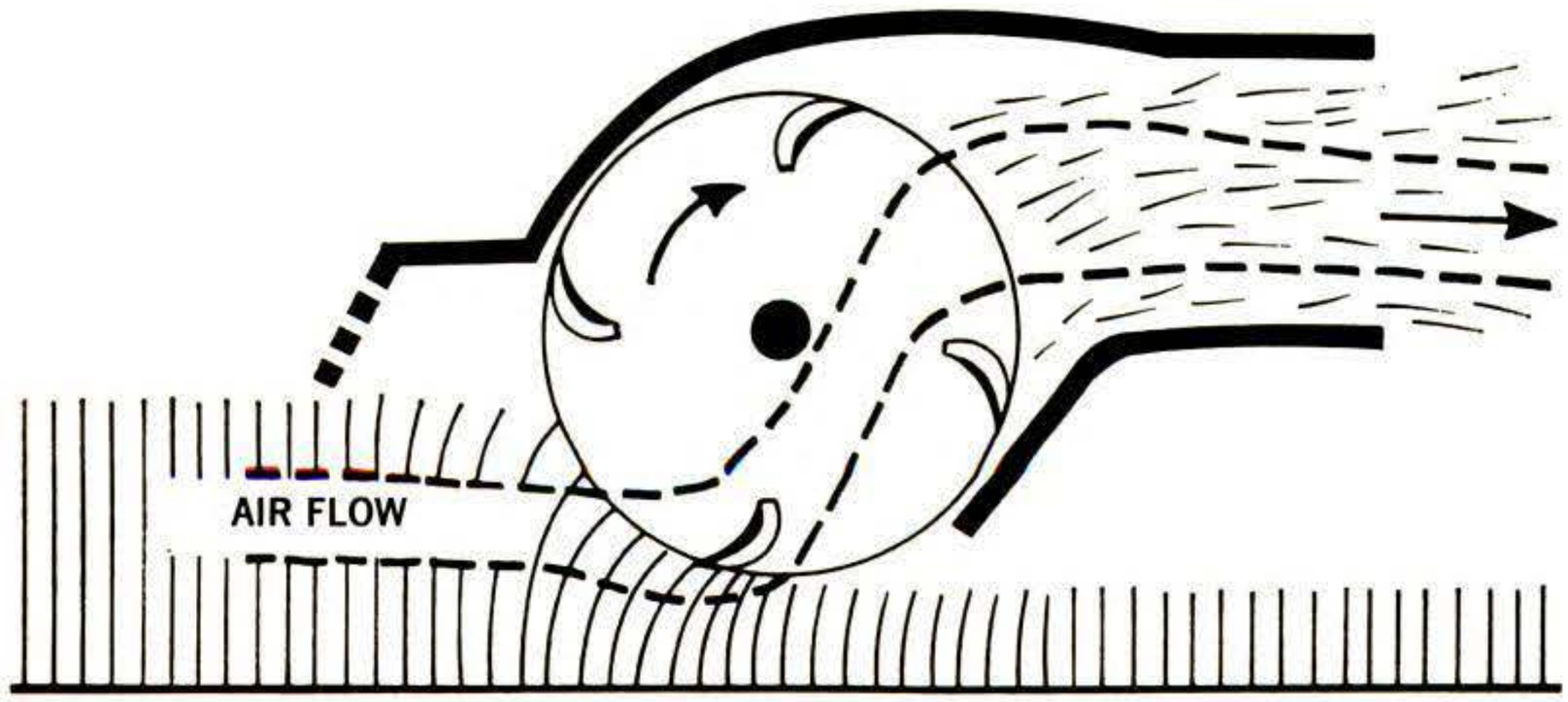
Vortex Mower Promises a

Your next power lawn mower might be a version of this new machine that harnesses a whirlwind to ease your garden chore

PHOTOS BY CARL HOWARD



The reel-vortex mower blades rotate away from you as it is pushed. But instead of pushing the grass away, whirling air around the blades lifts the grass and forces it against rotating blades. Heavy objects like stones and wire are pushed out in front of the mower at relatively low speeds.

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Revolution in Grass Cutting

By HAL BIRCH

A new type of power reel mower kicks up a storm to help it cut grass. The "storm"—a vortex of swirling air—is raised by its own blades. The result could be easier, safer lawn chores for you.

The inventor of the new reel-vortex mower, Dr. Hugo Ferguson, 39, of Troy, N.Y., claims it cuts a lawn more neatly than a reel mower, wades through three-foot-high hay with ease, and greatly reduces chances of mower accidents.

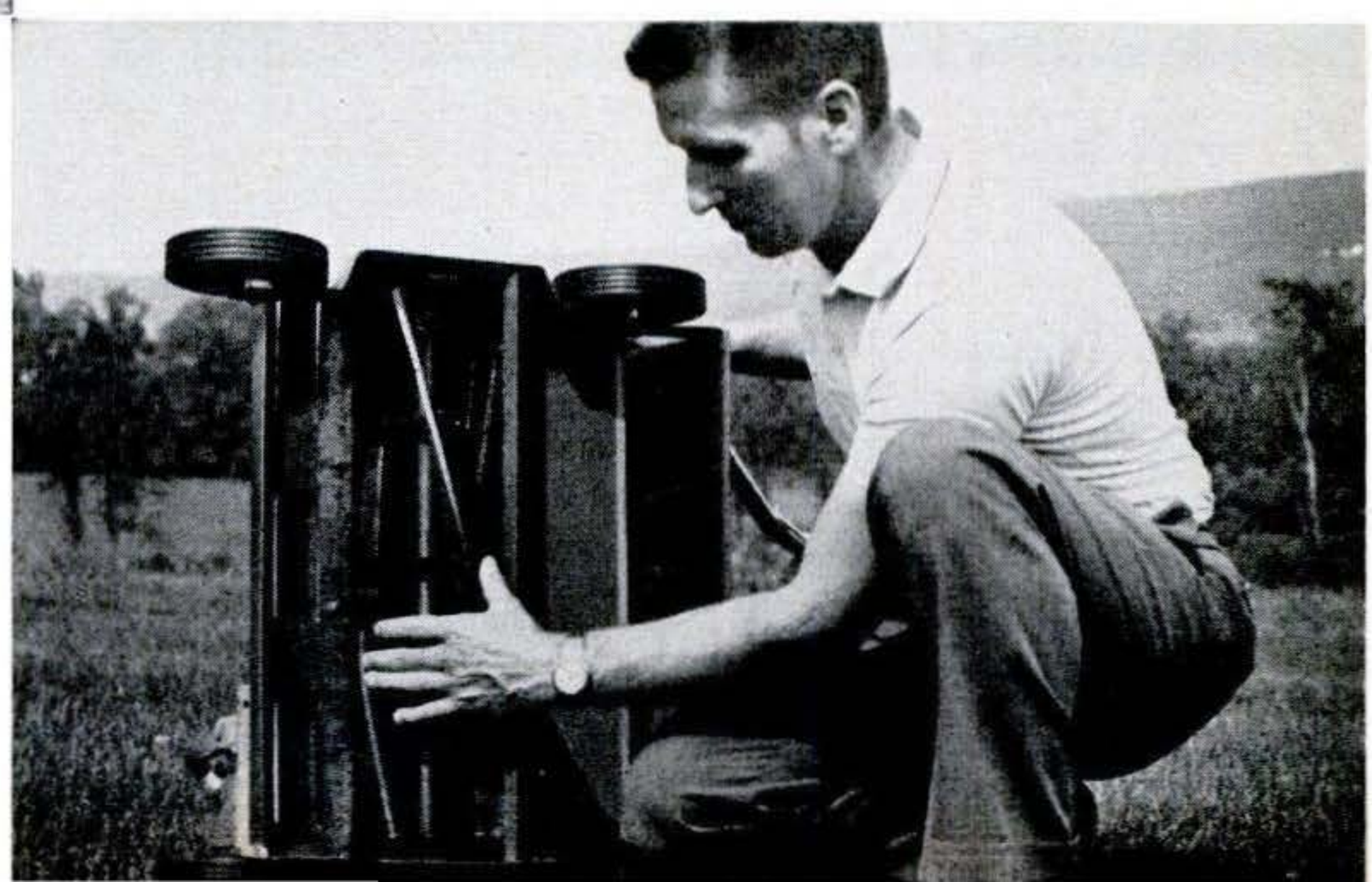
Several of the largest lawn-mower manufacturers have acquired prototypes from Dr. Ferguson's firm for testing. Among them is Lawn Boy. A spokesman for the firm says that they have not made a final decision on whether to start producing the mower.

What makes the reel-vortex mower different? It has a three-bladed reel whose bottom, unlike that of a conventional-reel model, rotates away from you as you push the mower. The blades would appear to push the grass *forward* once the mower was started. But the reel housing, which doubles as a safety guard, creates vortices of air around the blades.

These whirling winds lift the grass and flatten it back against the forward-rotating blades. Heavier objects, such as stones and wire, are propelled out the front of the Ferguson mower at relatively low speeds.

The device works much like a cross-flow blower, so the mower pulls in three to four times as much air as a rotary mower with the same cutting width. The air and grass are drawn back at 8,000 to 9,000 feet per minute. The mower actually vacuums the lawn! This vacuuming action allows the mower to cut wet or dry grass and blow it out the rear of the mower without clogging the blade or chute. In one

[Continued on page 220]



New mower cuts through three-foot hay with ease, unlike typical reel mowers, which get hung up on high grass. Whirling air flow blasts grass against blades so it's cut without ragged edges to turn brown.

There's an eight-inch space between the back wall of the reel-vortex mower and the protective reel housing. This provides double protection if foot slips under mower.

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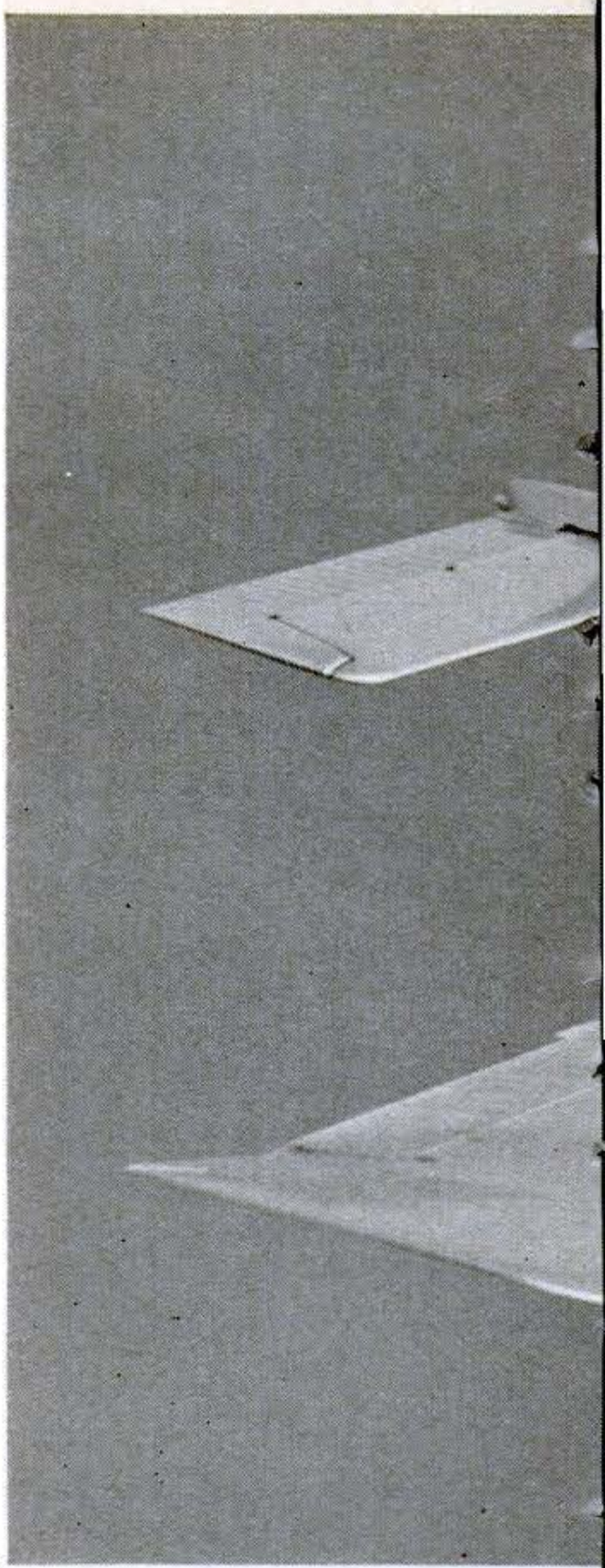
Sleek New Private Planes from Across the Seas

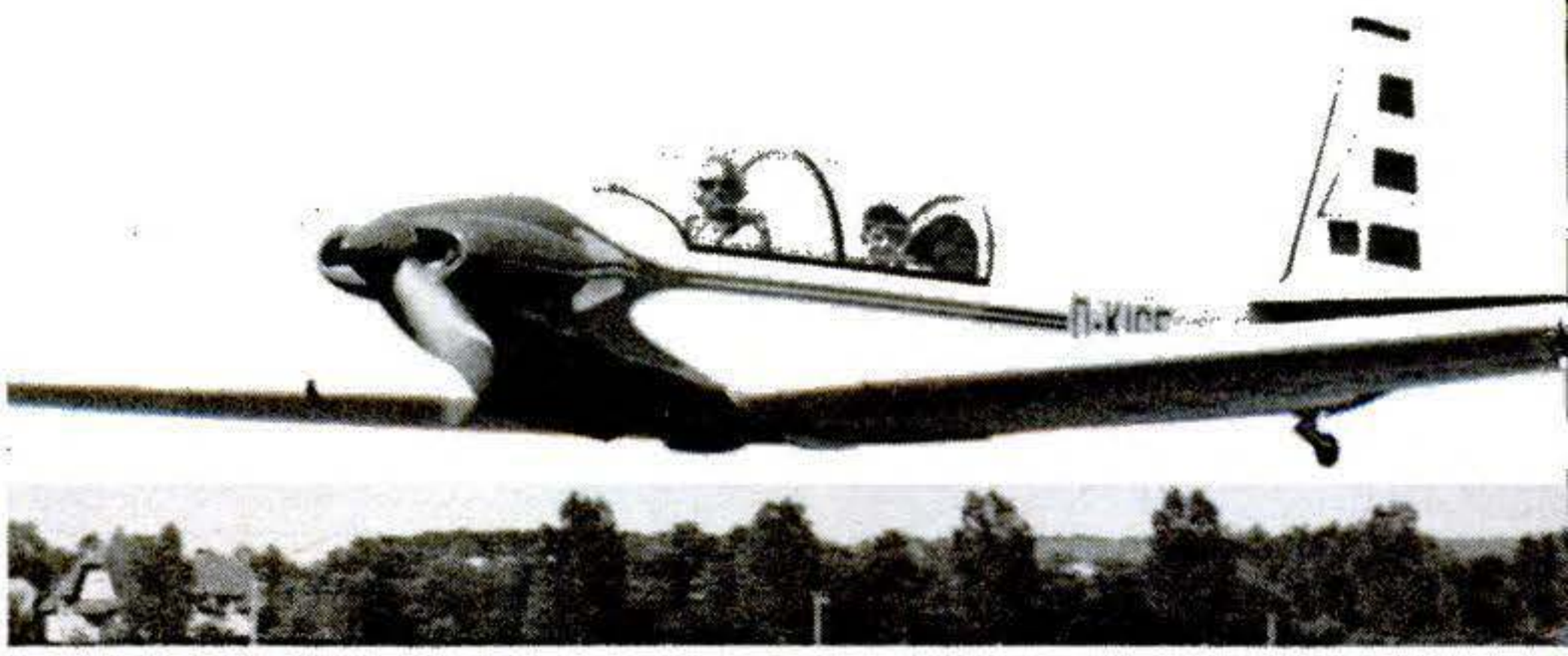
Bevy of flying beauties—many of plastic—includes a kit plane, folding-wing craft, aerobatic sports types, and powered glider

By BEN KOCIVAR



Britten-Norman BN-3 Nymph is new four-seater British plane designed to compete with three U.S. manufacturers for overseas markets. Nymph will be sold as knock-down kits of finished parts and assembled under license.

Bolkow BO 209 Monsun two-seater with folding wings comes in three engine versions: 115-, 150-, 160-hp. Lycomings. Nose wheel retracts in flight. Designed for aerobatics, training, glider tow.



Fournier RF5 is a two-seater that can soar with motor on or off and is stressed for aerobatics. Modified 65-hp. VW engine has electric starter for in-flight restarts. Fuel use is four gallons per hour, cruise speed 115 m.p.h. Single-seater version RF4 has crossed Atlantic twice.

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A plane in every garage? As of now, just a dream. But the international collection of the latest in small private planes shown here is proof that the dream of a personal pair of wings runs deep and strong, even if the reality is still elusive.

There are more private planes flying than ever before—126,000 general aircraft as of last year. Many of these, however, are owned by companies or by men who use them for business. For the individual who yearns only for the wild blue yonder, the deterrent is simply spelled out: M-O-N-E-Y.

There are practically no small radio-equipped planes available new under $8,000. [See "Flying the Yankee," PS July '69]. Most climb rapidly into the rarefied atmosphere of $12,000 and higher. When will there be a "VW" of the air? Perhaps not for a long while.

Right now, though, the plane makers represented in these pages are making private flying not only less expensive, but safer, smoother, and more fun. Their designs include an exciting new kit, fiberglass planes, powered gliders, some aerobatic craft, and even models that economize on hangar costs by folding their wings.

An ingenious attempt to reduce the cost of a four-place light plane was launched this year in Great Britain by Britten-Norman Ltd. This company, world-famous for its twin-engine Islander STOL, (a $70,000 nine-passenger short takeoff and landing plane), is coming out with a four-passenger high-wing craft called the BN-3 Nymph. They plan to market it worldwide next year as a kit. The kits, to be sold in units of five, will consist of fully finished, interchangeable parts to be assembled by licensed local dealers.

Continued

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Czech Zlin 42 is two-seater for training, glider towing, and continuing long tradition of outstanding aerobatic aircraft. Zlin-43, similar, carries four. Note sticks in cockpit. Both are all-metal planes.

The plane will be available with 115-130- and 160-hp. engines. Savings derive from the fact that some countries do not charge duty for parts as they do for a completed aircraft, and also in the reduced cost of shipping kits vs. airplanes. Cost of the completed Nymph, about $12,500, will thus be about the same as a Cessna 172 in the U.S., and somewhere between the Cessna 150 (two-passenger) and the 172 in some foreign markets. An order by a New Zealand dealer for 100 kits brought unit cost down to $7,435, including freight charges.

An interesting option is an inexpensive wing-folding kit, which reduces the space required for hangaring. Cruising speed is about 113 to 130 m.p.h., depending on engine horsepower, and it will take off in under 1,000 feet and land in just over 500 feet.

Another folding-wing design is the Messerschmitt-Bolkow BO 209 Monsun (Monsoon). The low wings of this two-seater fold straight back alongside the fuselage for stowing in confined space and also for towing along the highway. The fuel system has valves that close automatically when the wings fold back. Only three bolts on each side need be removed before folding. The all-metal two-seater also has an unusual tricycle landing gear. The nose-wheel folds back in flight, while the two wheels of the main gear remain fixed down.

Power plant is any of three engines: 115 hp., 130 hp., or 150 hp., all Lycoming. The side-by-side trainer is designed for aerobatics, including inverted flight. Price at the factory in Germany is $9,665 to $12,125, depending on engine. Cruising speed is 153 to 170 m.p.h., also depending on engine.

Still another spacesaver. A new two-seater, Sportavia Avion-Planeur RF5, a French design by Rene Fournier, now made in Germany, has outer panels which fold upward to reduce hangar space. Powered by a modified 1,600cc Volkswagen engine, this unusual plane looks like a powered glider, yet has performance that belies its appearance. It cruises at 120 m.p.h., stalls at 50, has a power-off sinking speed of about five feet per second at 65, and can cover about 700 miles at economy cruising speed.

The two-seater is aerobatic, as is a prior single-seater, the RF4D that uses a 40-hp., 1,200cc Volkswagen engine. Both have a one-wheel landing gear directly under the fuselage and small outrigger wheels under each wing to keep

All-plastic LFU-205, four-seater, makes aerodynamic use of high-finish characteristic of plastics as well as noncorrosive qualities. Prototype has survived great temperature variations and dynamic stress equivalent to 36,000 hours' flight.

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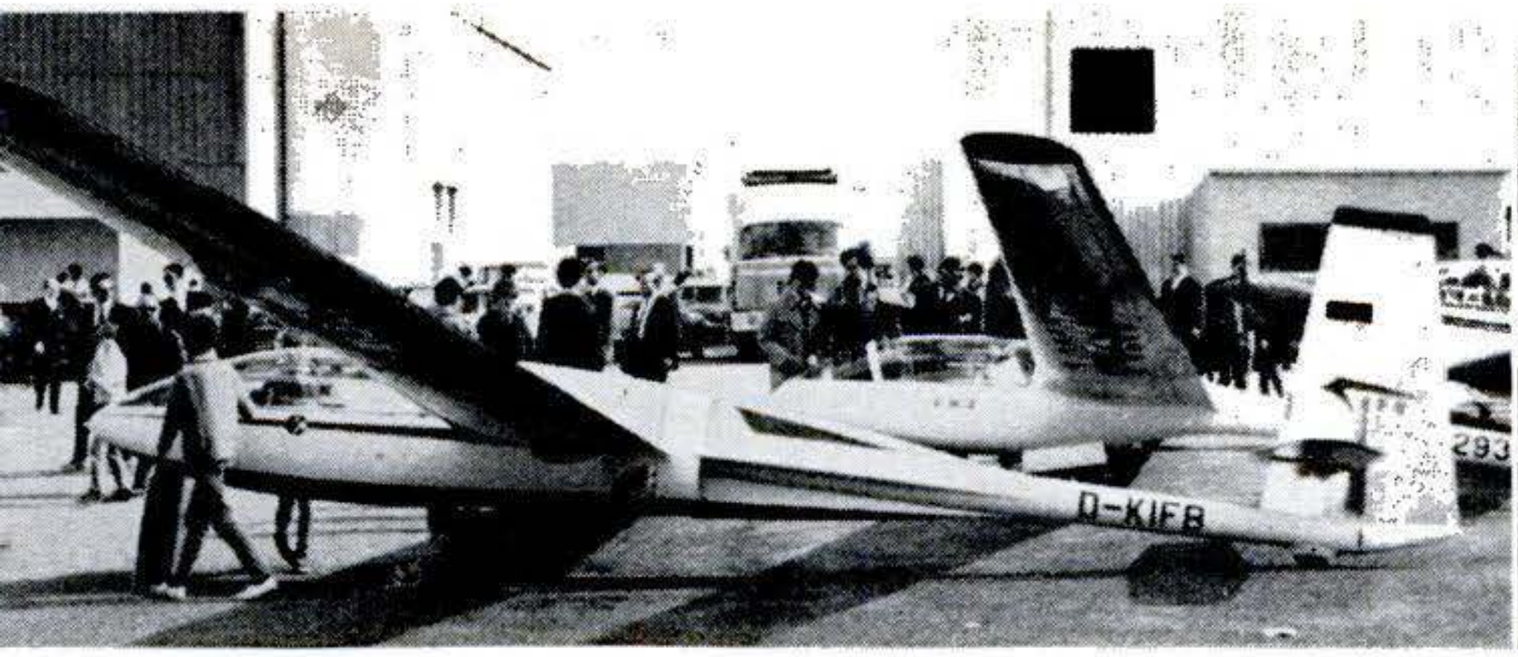

Rhein-Flugzeugbau Sirius, unique high-performance metal and fiberglass powered glider, has eight-blade ducted fan in midsection. Engine is American Nelson, a four-cylinder two-stroke, with 48 horses.

the wing tips from touching the ground. The single seater is the smallest plane to have flown the Atlantic, even with stops.

Both Fournier planes are single-ignition as of this writing, and thus are considered experimental by our FAA. However, a dual-ignition modification is expected this year. Price of the single seater, according to importer Bert Buytendyck, at Wooster, Ohio, is $8,200. The two-seater is expected to be $11,800. Both prices are without radio.

More a glider with power than the Fournier is a new high-performance sailplane called the Sirius, made in Germany by Rhein-Flugzeugbau GmbH, and also marketed through Sportavia-Putzer GmbH of Schmidtheim, Germany. It claims to be the first high-performance glider combining metal and fiberglass construction. Its small four-cylinder, two-cycle American Nelson engine delivers 48 hp., and includes an electrical starter for air starts.

Location of the engine and fan propeller is most unusual. It is directly in the middle of the fuselage, and the eight-bladed fan is shrouded and not readily visible from the side. The shroud protects the ground crew from the prop. In addition, the manufacturer claims the power system is fully free of torque. Wingspan is more than 60 feet, cruising speed is about 94 m.p.h., and best rate of descent is just under five feet per second. Minimum speed is 40 m.p.h.

Two new all-fiberglass planes appeared at the Paris Air Show. A French model, the Wassmer WA-51 Pacific, comes from a small manufacturer that has made some 1,500 small light planes and gliders. The four-place plastic prototype has doors that hinge upwards and retractable gear, and is similar in general appearance to the Wassmer super 4/21, which Mme. Hrissa Pellissier, an outstanding French lady pilot, flew around the world last year. And the price? It's expected to be competitive with four-place Piper Cherokees and Cessnas in this country.

Germany's LFU-205. This plane, which first flew last year, is a prototype four-seater with the airframe constructed of fiberglass-reinforced plastics. Its makers claim considerable weight-saving, performance improvement, and easier maintenance over comparable all-metal aircraft. Wing design is unusual, with a slight forward sweep. The craft has a corrugated inner skin laminated and bonded to a smooth outer skin. The

[Continued on page 226]

Midwing Bolkow Junior BO 208 has U.S. ancestry, but is produced in Sweden and Germany. Tiny two-seater is sold in 17 countries for training, towing, and fighting. Tricycle gear does not retract; there is a seaplane version.

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WANTED: A Devic
REWARD

in the Popular Science Anti-Car-Theft Devi

Build a working gadget to foil car thefts and enter it in this unique competition, aimed at curbing one of the nation's most serious crimes

By ERNEST A. ZADIG

Holder of numerous automotive, electrical, mechanical, optical, and radio patents sold to Bendix, Borg-Warner, RCA, General Mills, and others. He is also author of "The Inventor's Handbook."

A practical invention to prevent the unauthorized driving of an automobile could win you $20,000 and, as a bonus, give you the satisfaction of being the inventor who helped turn the rising tide of car thievery. If you fall short of the top, the POPULAR SCIENCE Anti-Car-Theft Device Competition sponsored by Allstate offers you 13 additional money prizes beginning with $2,500.

Don't overlook a great added value: Your invention will come to the personal attention of a jury whose opinions carry great weight in the automotive industry. This could lead to commercial success even if you don't capture the top prize. Most inventors are unable to arrange such an introduction to the industry on their own. The car makers don't put out the welcome mat, and they don't beat a path to the better mousetrap.

You will note the word "practical" right at the beginning, and I would like to stress it again as the key to the problem. In order to win, your device must be practical from the standpoint of its eventual manufacture, practical on the basis of the cost it adds to an auto, and above all practical in its adaptability to the way cars are designed and produced.

Let me show you one type of *im*practical idea to avoid. This is one from the sheaf of patents I selected out of the thousands of antitheft inventions I found on file in the Patent Office.

Send for Your Entry Form

Please send me an entry form so that I may enter the POPULAR SCIENCE Anti-Car-Theft Device Competition, sponsored by Allstate. I enclose a stamped, self-addressed envelope.

Name_____

Address_____

City_____ State_____ Zip_____

Inventors' Competition
POPULAR SCIENCE MONTHLY
355 Lexington Ave., New York, N.Y. 10017

CONTEST RULES

1 **All entries** must be accompanied by a filled-in entry form which can be secured by mailing coupon at left, or by writing to POPULAR SCIENCE Anti-Car-Theft Device Competition, 355 Lexington Ave., New York, N. Y. 10017.

A stamped and self-addressed envelope must accompany each request.

The completed entry form will warrant that *to the best of your knowledge* the submitted device represents your own original idea and that it does not infringe upon any existing U.S. patent.

2 **All entries** must be working models of devices that can be attached to or built into a car to prevent its being driven away under its own power by unauthorized persons.

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to Stop Car Thieves
$20,000 First Prize

Competition sponsored by Allstate Insurance Co.

1st Prize...$20,000
2nd Prize...$2,500 3rd Prize...$1,000
4th Prize...$500
Plus 10 Prizes of $100 each

This one hopes to make the engine unstartable by preventing completion of the circuit from battery to starting motor. A strong steel box guarded by a good tumbler lock contains a switch and is inserted in series into the starter cable. When this well-protected switch is locked in the open position, nothing can happen, even though the ignition key is turned to "start." Is this car protected against theft?

In the first place, this device is in a part of the circuit that must employ cable, not thin wire. This cable is made large and kept short to reduce voltage drop, which would weaken the starter's power.

The only way to avoid increasing starter-cable length when adding this gadget is to put it down in the oily guts of the engine compartment. Use a key down in that mess? Ugh!

The inventor evidently realizes this drawback, because he suggests that his little Fort Knox box be placed behind the instrument panel for easy key access. Un-

Continued

3 **The device** should require as little effort on the part of a driver as possible to render the vehicle undrivable to unauthorized persons.

4 **The device** should be designed so that it can be mass-produced cheaply, and the estimated manufactured price will be taken into account by our judges in awarding prizes.

5 **Each entry** must be sent by insured mail. A self-addressed label and sufficient postage must be enclosed with all devices the owners wish to be returned. POPULAR SCIENCE will use its best efforts to return all inventions entered in the competition, but will not be responsible or otherwise liable for any inventions that are not returned.

6 **Entries must be mailed** to POPULAR SCIENCE Anti-Car-Theft Device Competition, P.O. Box 772, Murray Hill, N.J. 07974.

7 **All entries must be postmarked** no later than December 31, 1969, and received no later than January 10, 1970, to be eligible.

8 **You may submit** as many devices as you wish; each entry must be sent in a separate container, and with a separate entry form.

9 **Winners will be selected** by a judging panel of seven experts, whose decision will be final. Winners will be notified by mail.

10 **Any U.S. resident** may enter the POPULAR SCIENCE Anti-Car-Theft Device Competition, except employees of POPULAR SCIENCE MONTHLY (and their families), of Allstate Insurance Co. (and their families) and/or their advertising agencies, or where prohibited by state or local laws or regulations. Taxes on prizes are the responsibility of winners.

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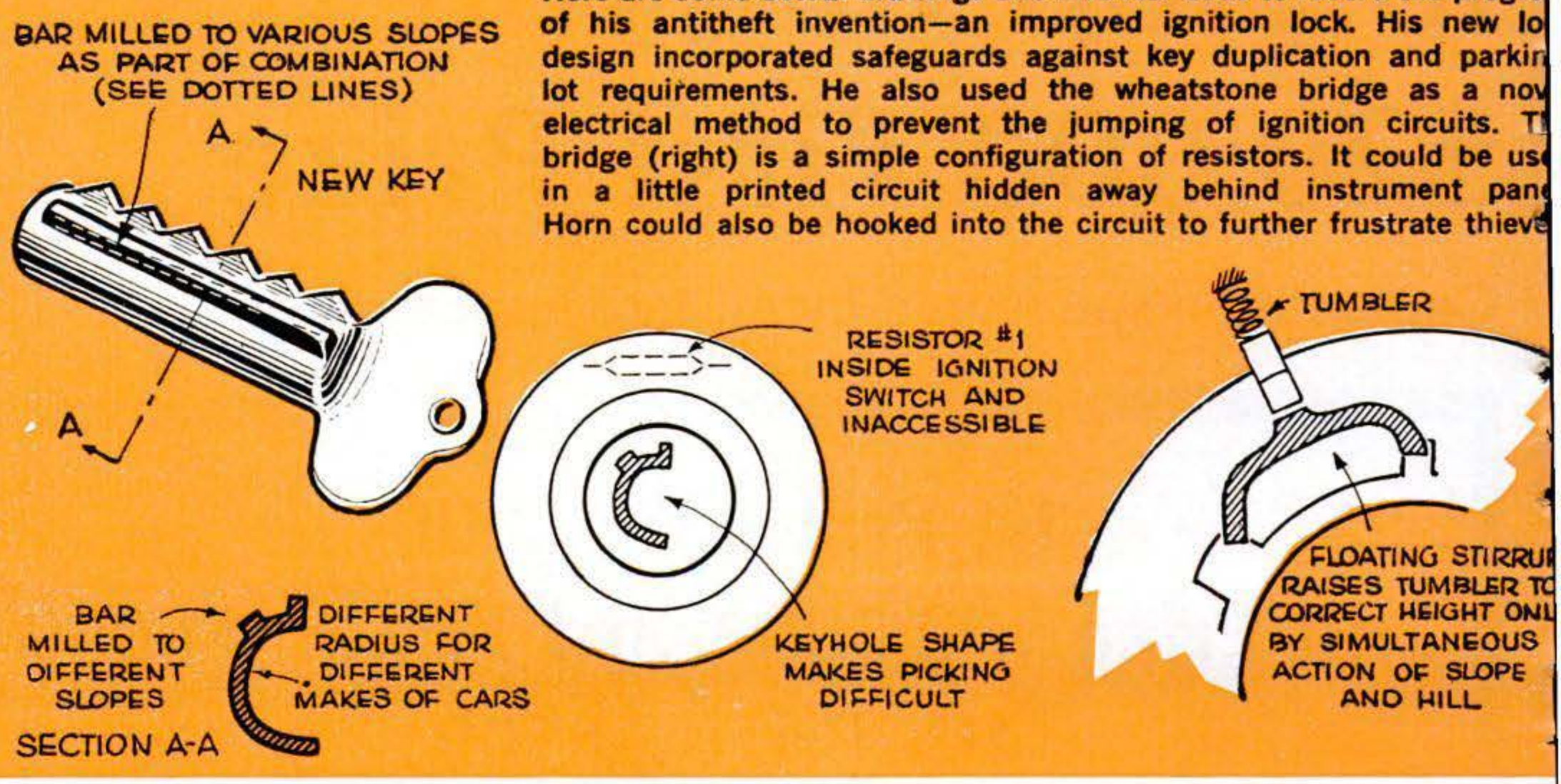
Drawings from an inventor's notebook

Here are some actual drawings one inventor used to record the progre of his antitheft invention—an improved ignition lock. His new lo design incorporated safeguards against key duplication and parkir lot requirements. He also used the wheatstone bridge as a nov electrical method to prevent the jumping of ignition circuits. T bridge (right) is a simple configuration of resistors. It could be us in a little printed circuit hidden away behind instrument pan Horn could also be hooked into the circuit to further frustrate thieve



fortunately, that would at least quadruple cable length. The main fault is even plainer: Simple jumping from battery to starter defeats the whole fancy business.

So much for the negative; now let's accentuate the positive. What types of theft-preventers are most likely to lead you into the winner's circle? A definitive answer is impossible, of course, because it would be an attempt to outguess the inventive ability of PS readers. But a few generalizations based on my own analysis of the problem might prove helpful.

Suppose your mind runs to locks. Locks, as such, have been downgraded as an effective deterrent to automobile theft, but this does not mean that a better lock in a better system could not be effective. Locks have suffered from guilt by association rather than because of their own shortcomings.

An example is the case of locks on several popular makes of automobiles whose combination sequences remained unchanged by the manufacturers for more than three decades. A thief with some keys in his pocket was fairly sure to make a haul. A cheap, easily available master key became almost a guarantee of success.

To make matters worse, these locks were mounted in the instrument panel switch and connected via accessible, unprotected wire which anyone could jump. The driver compounded the felony by not removing his key when he left the car. Parking-lot attendants required the key and often had duplicates made surreptitiously. Nevertheless, the locks were blamed when theft occurred, even though locks were not actually at fault.

Now, with all this in mind, if you still think an improved locking system is your best approach to a prize, you might do your thinking along these lines:

The key challenge. The key would have to be nonduplicable. The hill-valley tumbler mechanism could be retained because of the wealth of combinations it affords, but additional safeguards must be added. These would show on the key as perhaps variations in thickness, reentry angles, helixes, or holes of varying depth. Such configurations would present no problems in the manufacture of the original key, but would be tough stymies for key-duplicating machines to overcome.

Your proposed lock system, in my opinion, should eliminate the "key-left-in-lock" syndrome, which is the one biggest contributor to auto theft. It must do this in some manner not objectionable to the driver. It must also accommodate parking lots that want the key to be left.

Your qualifying lock system also must be invulnerable to jumping. It must accomplish this in a *practical* manner.

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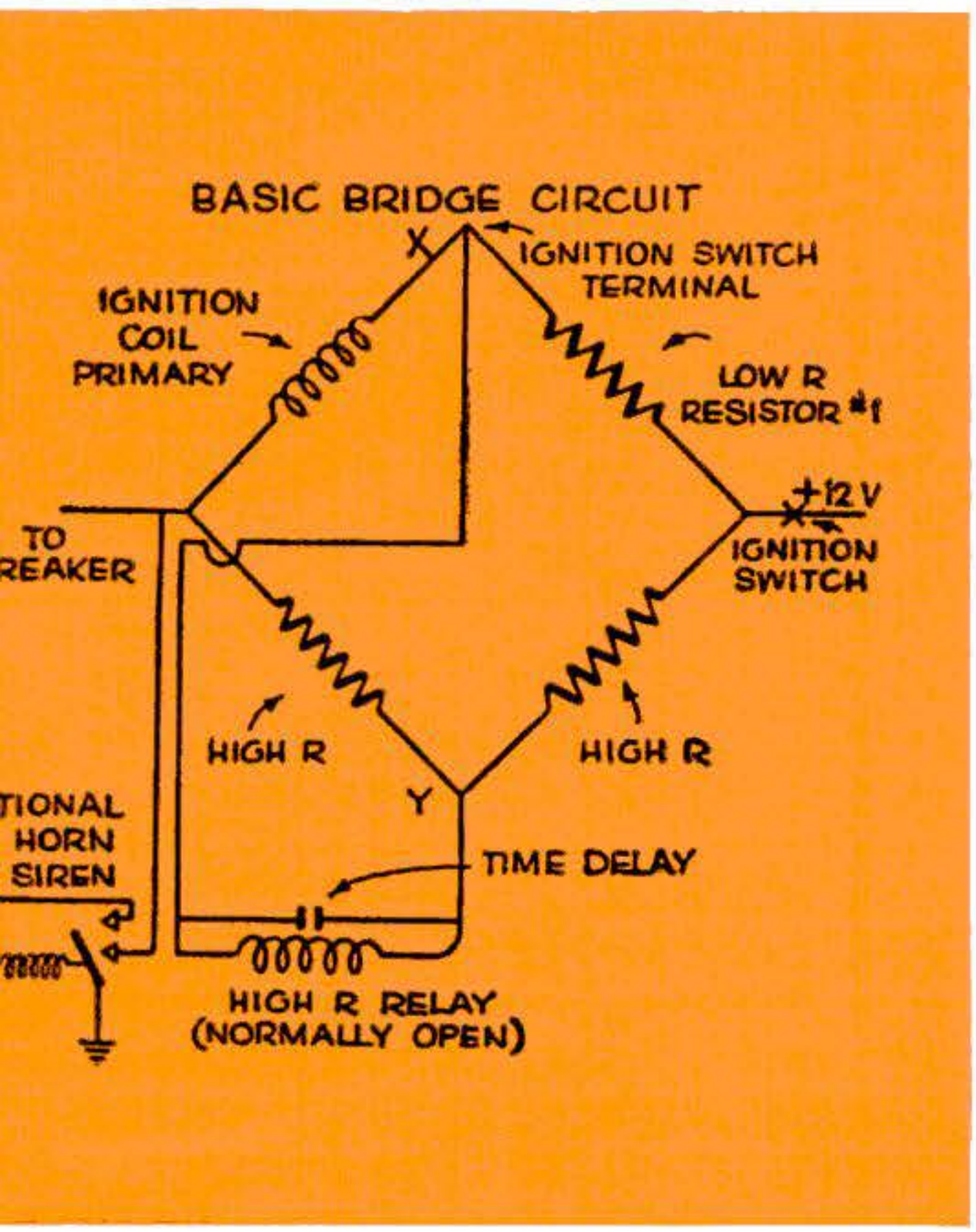

(Early efforts to prevent jumping enclosed all wires in hacksaw-proof conduits. Car makers considered this impractical—meaning too cumbersome as well as too expensive.)

Steering-wheel locks. You might want to make an outstanding improvement in steering-wheel locks, which have just returned to automobiles after an absence of some 30 years. This form of protection is proving effective against thieves. Police statistics show a marked decrease in thefts of cars so equipped.

Of course, the lock and its key are only one corner of the wide realm in which you can exercise your inventive skill. The various approaches to immobilizing an automobile were pointed out last month, and any one of these may be particularly appealing to you. Nor can we rule out the genius who will make everything we are now thinking obsolete.

How to proceed. Suppose you have finally selected a path to your goal. What is a business-like procedure for you to follow now in creating your invention? I happen to know the details of a recent project, and so I can give you a figurative look over a professional inventor's shoulder. This is the play-by-play account as I witnessed it:

Because of (or perhaps, despite) the wide use and low accomplishment of ignition locks, the inventor felt that this field held the greatest possibilities. It was least likely to cause customer opposition because everyone is used to ignition locks. It was most likely to meet with manufacturer approval because it upset no factory applecarts. The Patent Office files were bulging with horrible examples from which to learn, then avoid.

The problem resolved itself into two parts. One—the lock—was mechanical. The second—the ignition wiring—was electrical. Neither required an Edison, a Newton, nor an Einstein, but only some honest mental effort.

The inventor squared his new lock design away with due safeguards against key duplication, key leaving, and parking-lot requirements. (Now you can guess where I cribbed my earlier hints on lock construction.)

The inventor decided on a novel *electrical* method for preventing the jumping of ignition circuits. This would eliminate the cumbersome and expensive conduits and barriers used in the past. It would add almost negligible cost to an automobile. There seemed to be no issued patents to block it.

The wheatstone bridge. The nub of his idea centered around the wheatstone bridge. You may remember this gadget from your physics classes. It is a simple configuration of resistors, and it derives its value from the manner in which it directs the path of a current of electricity impressed upon it. The whole "works" could be encompassed in a little printed-circuit chit hidden away somewhere in the jungle behind the instrument panel but still in the driving compartment.

If the ignition were turned on with the authorized key, the designed electrical balance would be maintained and everything would function normally. If the wires were jumped in lieu of a key (no attempt would be made to hide them) the balance would be upset; no current would reach the coil, or else the coil would be short-circuited to ground. Either of these conditions would keep the motor dead. If you wanted to be mean and further frustrate the poor thief, the horn could be hooked into the circuit to blow at every jumping attempt.

The idea looked good. The resistances

[*Continued on page 230*]

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More Safety, Cleaner Exhaust, and Better Repairability

IN THE '70 CARS

Most of the improvements in the new models are hidden under the skin—but they're real

By **JAN P. NORBYE** / *PS Automotive Editor*
and **JIM DUNNE** / *PS Detroit Editor*

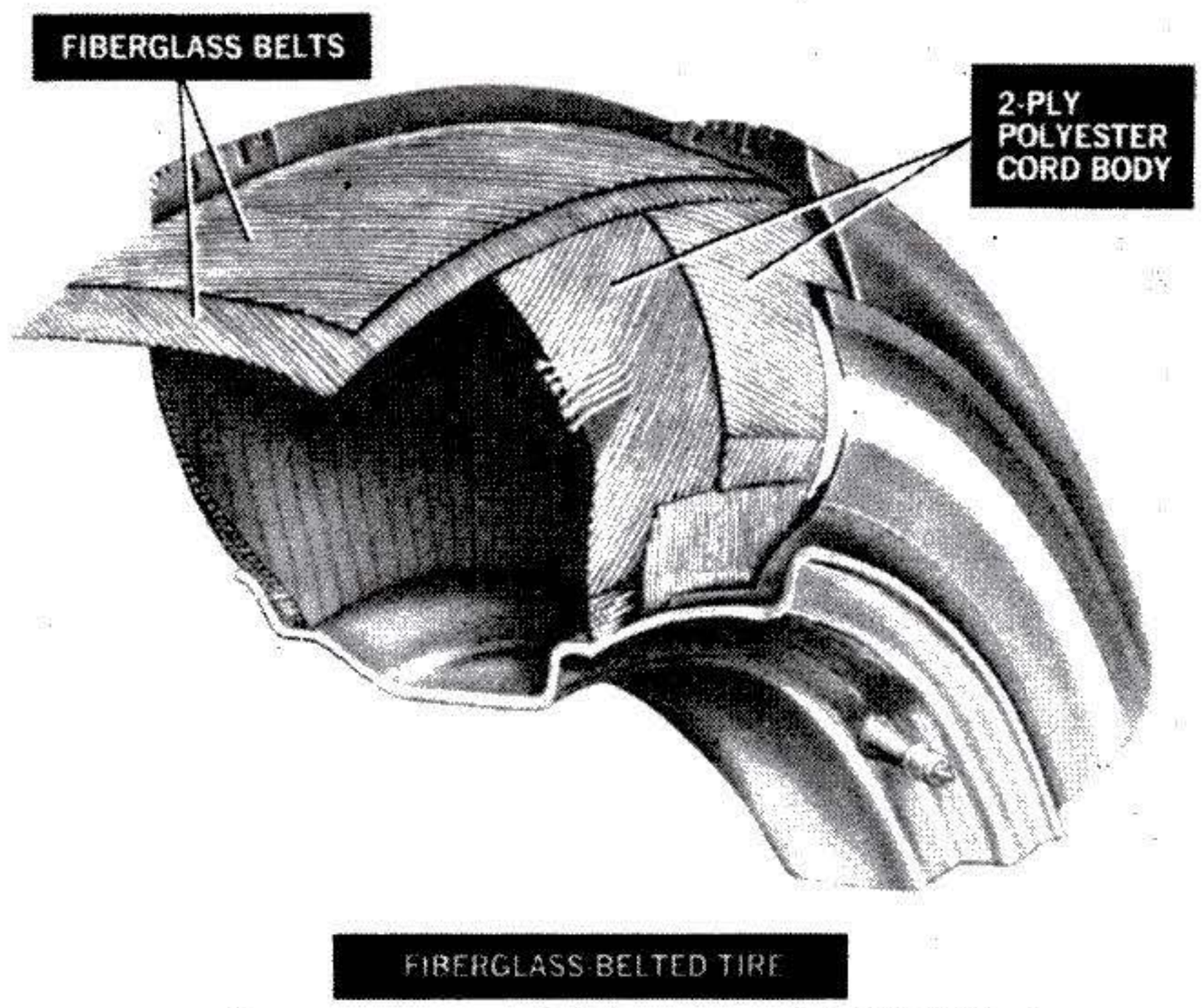
You have probably been looking at '70 cars for a couple of weeks now, and you may well be thinking that most of them don't look much different from last year's models. In fact, some aren't changed at all, and the new features of others are practically invisible.

Were the '69 cars so beautiful and so technically perfect that they couldn't be improved? You know better than that. The truth is that for 1970, Detroit has aimed its engineering efforts primarily at meeting safety and air-pollution standards. Design innovations and major changes were put aside until some later date. You will also discover that Detroit is making progress in keeping cars out of the repair shop for longer periods, finally doing something towards making repair jobs easier.

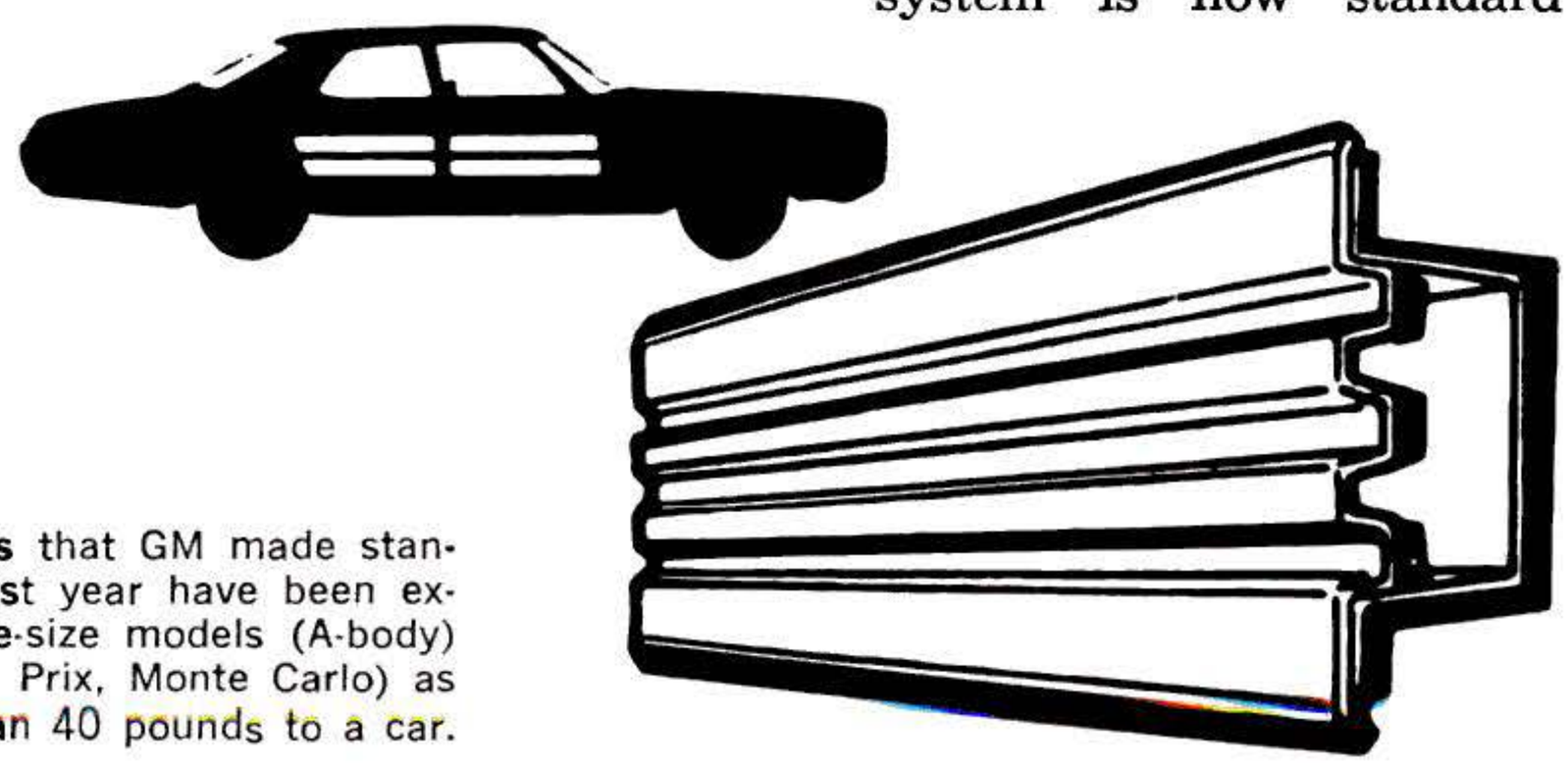
This year we have made a special study of Detroit's activities in these three areas: Safety, exhaust control, and repairs. Let's start with safety. Here are the major developments:

- Antilocking brakes
- Safer tires
- Rollover structures

Ford Motor Company's Sure-Track antilock brake system is now standard



The fiberglass-belted tire will be standard on all but two '70 cars from Detroit. Its main advantages are longer tread life, improved wet traction, higher speed capacity, greater impact strength, and higher resistance to road hazards.



The guard rails inside doors that GM made standard on its full-size cars last year have been extended to GM's intermediate-size models (A-body) and the G-body cars (Grand Prix, Monte Carlo) as well. The bars add more than 40 pounds to a car.

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Oldsmobile offers this optional hood-release lock fitted under the instrument panel—an item that is standard on many low-priced imported cars. Since the introduction of the ignition key that also locks the steering and transmission systems, GM has taken the lead in adding theftproofing equipment.

equipment on the Continental Mark III (it was optional in 1969). In case you've forgotten, it has electronic speed sensors in the rear wheels. These signal to a control unit, which adjusts brake-line pressure to the rear wheels in case of excessive deceleration. The automatic apply-and-release cycle can be repeated up to five times per second. The same system is a $180 option on regular Lincolns and Thunderbirds.

General Motors intended to make a somewhat similar system available on the Toronado and the Riviera for

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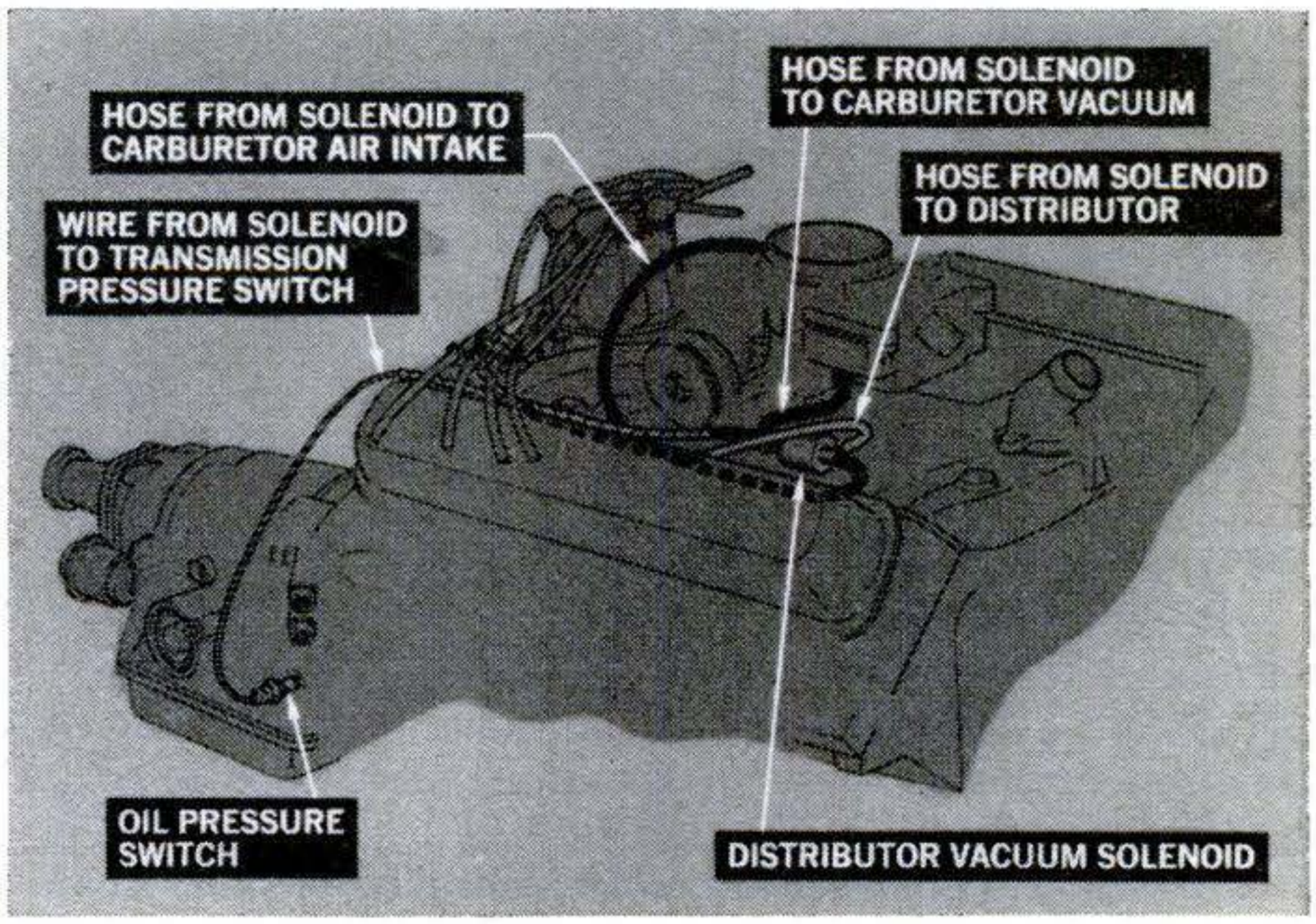

Transmission-controlled spark is the name of General Motors' latest development for cleaner exhaust. It is standard on all engines. With manual gearboxes, the transmission connection is mechanical.

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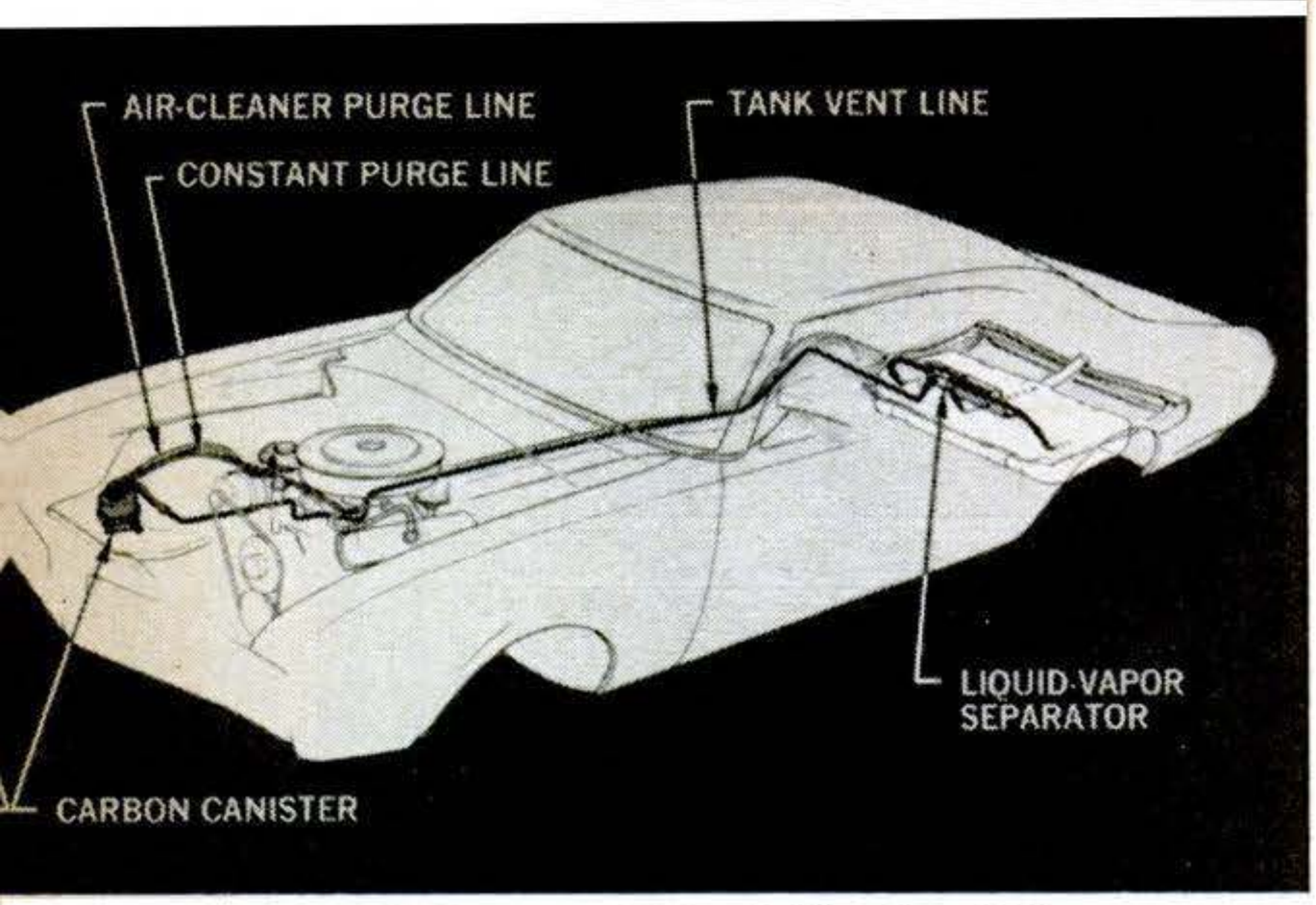

All 1970 cars sold in California will have an evaporation control system. The Oldsmobile system uses a carbon canister to trap vapors, has a return line with a separator feeding gasoline back into tank.

'70, but there will be some delay. The best you can hope for is midyear installation. Many leading experts at GM want a four-wheel antiskid system, and this may be what is holding up the rear-wheel-only device.

When you look at what's happening in tires, it's Ford in the lead again. Michelin X 225R-15 radial-ply steel-belted tires are standard on the Continental Mark III, and B. F. Goodrich 990 215R-15 all-rayon radial-ply tires are standard on the Thunderbird. For all-round safety and long life, the radial-ply tire is recognized as unbeatable [PS, Apr. '68].

Tire safety will show up on most other cars as the entire industry switches to fiberglass-belted bias-ply tires. This type of tire was introduced by Goodyear 18 months ago and sold by that company under the Polyglas trademark. Other tire companies will join in supplying this tire type for the '70 cars. In addition to the longer tread life and greater hazard resistance of the bias/belted tire, most tires will have a wider tread. Take the standard tire on Dodge Coronets as an example; it will go up one full size from 7.75 to 8.25 on cars equipped with V-8 engines.

Roll cages. Bit by bit, Detroit is building them into car substructures. Chrysler's new Barracuda and Challenger have a roll bar built into the roof ahead of the rear window. The bar is box-section sheet metal, and along with similar supports in the roof rails and windshield header, makes up a "rollover structure." These two cars also have steel structures in the doors to resist penetration in side-impact accidents, similar to that pioneered by GM's 1969 models. Side-impact bars are built into all the 1970 GM intermediate cars, including the Monte Carlo and Grand Prix for the first time.

Windows are being altered for safety, too. American Motors is pioneering a special windshield that is designed to reduce the possibility of facial injuries in accidents. The Chemcor windshield has a chemically strengthened inner pane that granulates into minute, blunt-ended particles on impact. Its resilient action helps cushion head blows, and keep it from penetrating. As the windshield is thinner, it also defrosts about 30 percent faster.

Since stolen cars tend to get into accidents, antitheft aids are also safety devices. In 1970, all cars will have steering-column and transmission locks. Most GM divisions also offer optional hood-release locks.

Other safety items:

- Pontiac station wagons have a new all-plastic fuel tank that will be safer in a crash.
- All Ford Motor Co. products have a three-point-clasp shoulder and lap belt that eliminates one buckle.
- Fingertip-reach washer/wiper buttons are standard on Oldsmobile and Monte Carlo. Olds carries the button in the tip of the shift lever; Monte Carlo in the turn-signal stalk.
- Buick has a new proportioning valve for more accurate front-to-rear distribution of brake pressure.
- Defroster wires in the rear-window glass are optional on Ford and Mercury, most GM cars.
- Blower-type rear-window defrosters are available on all American Motors cars and Ford Motor Co. intermediates.
- Only station wagon with any kind of tailgate window defroster is Buick's new Estate Wagon. It's a blower type.
- Most GM cars are available with very quick variable-ratio power-steering systems. Variable ratios with slower progressivity are available on all AMC cars.
- AMC has 12-inch-wide mirrors (interior).
- Chrysler offers a plastic baby-safety seat, held in place by a regular seat belt.

Air-pollution control. Stratified-charge fuel injection is still a long way from production. The industry is mainly occupied with small changes that produce small improvements. Most GM cars have the Olds-

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developed transmission-controlled spark advance that directs the distributor timing to burn fuel most effectively, with full regard to load. TCS provides vacuum spark advance only in top gear with both automatic and manual transmissions.

Because of the success of Oldsmobile's Climatic Combustion System (which mixes preheated air with ambient air so as to feed the engine air at a constant 100 degrees), Olds has now dropped the heat-riser valve on all engines. This cuts manufacturing costs, and saves a lot of maintenance.

Buick is introducing a Time Modulated Choke Control System designed in compliance with emission standards for 1970. A secondary choke control gradually reduces choke enrichment during a six-to-12-second period following cold start. That's before the main choke has a chance to start opening. It is claimed to give quicker cold starts, lower emissions.

Heated-air system. Chrysler Corp. has a heated-air system that reduces emissions by one-third as a result of enabling the engine to run on leaner mixtures. Heated inlet air maintains the temperature of air entering the carburetor at 100 degrees or higher. On a car without heated inlet air, the engine requires a richer fuel-air mixture to maintain optimum performance on a cold day.

The heated-inlet air system uses a sheet-metal stove attached to the engine exhaust manifold. Exhaust gases passing through the manifold cause it to heat up rapidly. Underhood air is heated as it is drawn through this stove over the hot manifold.

A faster-operating (opening) choke was put on 340, 440 (Six-Pak), and 426 hemi to help reduce emissions. On Chrysler 318, 383, 440 (Six Pak), the compression ratio was reduced to lower hydrocarbon emissions. The idle speed setting on Chrysler's 340 was raised to 800-1,000 r.p.m. to lower hydrocarbon emissions during idle and deceleration. Finally, distributors have more accurate spark timing with spark advance tolerances reduced as much as one half; and all carburetors are new, designed to cut down emissions.

California has always had stricter air-pollution standards than other states, and for 1970, California demands fuel-evaporation control (see drawing, facing page).

Oldsmobile now installs valve rotators on all engines in place of the simple valve-spring caps used on last year's models. The valve rotators assure even seating and a tighter seal, and practically eliminate the risk of valve-face deposits. The rotators operate only when the valve is opening—never when it closes. This eliminates wear that would be caused by the valve head rubbing against the seat.

GM and Ford have generally similar systems, with a vapor reservoir, a liquid/vapor separator, and a return line to the tanks [PS, July].

Chrysler's system, which cuts raw gasoline vapors by 80 percent, vents gas vapors directly into the engine crankcase. They are drawn off by the PCV system

[Continued on page 222]

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Facts and Figures on the

Dimensions MAKE AND MODEL		WHEELBASE (in.)	TRACK, FRONT (in.)	TRACK, REAR (in.)	LENGTH (in.)	WIDTH (in.)	HEIGHT (in.)	CURB WEIGHT (lb.)	LEG ROOM (in.)		HEAD ROOM (in).	
									FRONT	REAR	FRONT	REAR
Ambassador		122	59.7	60.0	208.0	77.2	54.2	3,405	42.0	38.6	39.5	37.
AMX		97.0	59.1	56.6	179.0	71.6	51.2	3,160	42.7	—	37.2	—
Buick	Skylark sedan	116	59.0	59.0	204.7	75.6	54.1	3,393	41.3	34.8	38.7	37.
	Skylark coupe	112	59.0	59.0	200.7	75.6	53.4	3,317	42.1	33.1	37.8	36.
	Le Sabre	124	63.0	63.0	219.4	80.0	55.4	4,152	42.3	37.9	39.1	37.
	Wildcat	124	63.5	63.0	219.4	80.0	55.4	4,321	42.2	37.5	37.6	36.
	Electra 225	127	63.5	63.0	225.0	80.0	55.9	4,445	42.2	40.9	37.4	38.
	Riviera	119	63.44	63.0	215.5	79.3	53.6	4,374	41.2	36.6	37.7	37.
Cadillac	Calais/deVille	129.5	63.0	63.0	225.0	79.8	54.4	4,560	41.2	39.7	38.5	38.
	Fleetwood 75	149.8	63.0	63.0	245.5	79.8	58.1	5,220	40.8	NA	40.3	38.
	Eldorado	120.0	63.5	63.0	221.0	79.8	53.7	4,700	41.4	36.2	37.5	37.
Chevrolet	Nova	111	59.0	58.9	189.4	72.4	53.9	3,037	41.7	35.5	38.9	37.
	Camaro	108	59.6	59.5	186.0	74.0	51.6	3,170	42.5	29.2	37.1	36.
	Chevelle sedan	116	59.8	59.8	201.2	75.4	53.5	3,513	42.8	35.0	38.4	37.
	Chevelle coupe	112	59.8	59.8	197.2	75.4	52.8	3,411	42.8	32.6	37.7	36.
	Chevrolet	119	62.5	62.5	215.9	79.8	55.5	3,931	41.4	39.6	38.9	37.
	Monte Carlo	116	59.0	59.0	205.8	75.6	52.9	3,563	42.8	32.6	37.7	36.
	Corvette	98	58.7	59.4	182.5	69.0	47.8	3,245	43.0	—	36.2	—
Chrysler	300/Newport/New Yorker	124	62.0	62.0	225.1	79.0	55.9	4,335	41.8	41.5	38.1	37.
Dodge	Dart	111	57.4	55.6	196.2	69.6	54.5	2,985	41.7	35.7	38.3	37.
	Challenger	110	59.7	58.7	191.3	76.4	51.4	3,125	42.3	30.8	37.4	35.
	Coronet	117	59.7	58.7	209.2	76.7	54.5	3,270	41.9	36.2	38.6	37.
	Charger	117	59.7	58.7	209.2	76.7	54.5	3,395	41.4	36.2	37.4	36.
	Polara/Monaco	122	62.1	63.4	219.9	79.2	56.4	3,990	41.8	39.7	38.8	38.
Ford	Maverick	103	55.5	55.5	179.3	70.6	52.3	2,500	41.3	31.9	37.6	36.
	Falcon	111	58.8	58.5	184.3	73.2	54.4	2,852	42.4	33.8	38.8	37.
	Mustang	108	58.5	58.5	187.4	71.7	51.5	3,080	41.1	28.8	37.6	35.
	Torino	117	60.5	60.0	206.2	76.4	53.0	3,300	42.2	36.0	38.0	36.
	Ford	121	63.0	64.0	216.0	79.8	54.9	3,751	42.1	38.3	39.2	37.
	Thunderbird 2d	115	62.0	62.0	212.5	78.0	51.4	4,586	42.1	32.0	37.1	36.
	Thunderbird 4d	117	62.0	62.0	215.0	77.4	53.6	4,696	42.1	35.3	38.1	36.
Hornet		108	57.5	57.0	179.3	71.1	52.6	2,725	41.7	36.8	38.0	37.
Imperial	Crown, Le Baron	127	62.4	62.0	230.2	79.1	55.7	4,925	41.9	41.2	38.3	37.
Javelin		109.9	59.1	56.6	191.0	71.9	51.6	2,893	42.7	31.5	37.5	36.
Lincoln	Continental	127	64.3	64.3	225.0	79.6	55.7	4,910	41.9	41.9	39.0	38.
	Mark III	117.2	62.0	62.0	216.1	79.4	53.7	4,846	42.1	34.7	37.1	36.
Mercury	Cougar	111.1	58.5	58.5	196.1	74.3	51.6	3,431	41.1	30.6	37.6	35.
	Montego	117	60.5	60.0	209.9	77.3	53.2	3,247	42.0	35.9	37.9	36.
	Cyclone	117	60.5	60.5	209.9	77.3	52.4	3,260	41.9	33.4	37.5	36.
	Monterey	124	63.0	64.0	221.8	79.8	55.2	4,017	41.7	38.3	38.7	37.
	Marauder	121	63.0	64.0	219.1	79.6	53.5	4,100	41.7	34.1	37.6	36.
	Marquis	124	63.0	64.0	224.3	79.8	53.9	4,175	41.7	39.7	37.7	36.
Oldsmobile	Cutlass sedan	116	59.0	59.0	205.9	76.2	53.5	3,421	42.8	35.0	38.8	37.
	Cutlass coupe	112	59.0	59.0	203.2	76.2	52.8	3,671	41.4	34.1	37.9	36.
	Delta 88	124	62.5	63.0	219.1	79.9	55.5	4,174	42.5	39.6	39.4	37.
	98	127	62.5	63.0	225.2	80.0	55.8	4,397	41.7	40.9	39.7	38.
	Toronado	119	63.5	63.0	214.3	78.8	52.8	4,459	41.3	35.5	37.7	37.
Plymouth	Valiant	108	57.4	55.6	188.4	71.1	54.0	2,910	41.7	34.5	38.4	37.
	Barracuda	108	59.7	60.7	186.7	74.9	50.9	3,150	42.3	28.9	37.4	35.
	Belvedere	116	59.7	59.2	204.0	76.4	54.8	3,205	41.9	36.3	38.6	37.
	Fury	120	62.0	62.0	215.3	79.6	55.1	3,785	41.8	38.0	38.8	38.
Pontiac	Firebird	108.1	60	60	191.1	73.9	49.5	3,218	42.5	29.5	37.5	36.
	Tempest sedan	116	61	61	206.5	76.7	52.0	3,396	42.5	34.8	38.5	37.
	Tempest coupe	112	60	60	202.9	76.7	52.0	3,336	42.4	31.9	37.7	36.
	Catalina/Executive	122	64	64	217.9	79.8	54.8	4,167	42.4	38.1	39.0	37.
	Bonneville	125	64	64	224.6	79.8	55.0	4,358	42.4	38.1	39.0	37.
	Grand Prix	118	62	60	210.2	75.7	52.0	3,953	42.4	31.6	37.5	36.
Rebel		114	59.9	60	199.0	77.2	55.0	3,155	42.0	38.6	39.5	37.

NOTES: All dimensions refer to four-door sedans. If there is no sedan in the li

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'70 Cars

You'll find some new names this year, and some old ones gone. But you've never had a wider choice of models, or as many options

HIP ROOM (in.)		USABLE TRUNK SPACE (cu. ft.)	TURNING DIAMETER (ft.)	STEERING-WHEEL TURNS LOCK TO LOCK		BASE TIRE SIZE	FUEL-TANK CAPACITY (gal.)	AXLE RATIO STD. SIX		AXLE RATIO STD. V-8		OPTIONAL AXLE RATIOS				
FRONT	REAR			Manual	Power			Manual	Auto.	Manual	Auto.	Economy		Towing				
60.3	60.4	18.0	40.4	6.0	3.2	F78-14	21.5	3.15	3.15	NA	2.87					
57.6	—	9.6	32.8	5.0	3.2	E78-14	19	NA	NA	3.54	2.87			3.91		
59.6	59.4	13.5	40.6	5.56	4.06	G78-14	20	3.23	2.93	2.93	2.56			3.42		
60.0	59.5	13.7	39.9	5.56	4.06	G78-14	20	3.23	2.93	2.93	2.56			3.42		
63.9	62.9	18.5	42.2	6.7	3.3	H78-15	25	NA	NA	3.23	2.93	2.73		3.23	3.42	3.64
63.4	62.6	19.5	42.2	6.7	3.3	H78-15	25	NA	NA	2.78	2.78			3.23	3.42	3.91
63.5	62.6	20.5	46.1	NA	3.3	J78-15	25	NA	NA	NA	2.56			2.78	3.23	3.91
62.2	54.2	14.7	43.4	NA	2.9	H78-15	21	NA	NA	NA	2.78			3.07	3.23	3.42 3.91
62.8	62.7	20.0	47.8	NA	2.8	L78-15	26	NA	NA	NA	2.93					
62.9	57.8	21.0	57.4	NA	2.8	L78-15	26	NA	NA	NA	3.15					
61.2	54.2	14.6	44.8	NA	2.7	L78-15	24	NA	NA	NA	3.07					
56.2	56.1	14.6	40.4	4.8	3.1	E78-14	18.5	3.08	2.73	3.08	2.73	2.56		3.31		
56.3	54.6	8.5	37.5	4.8	2.16	E78-14	18	3.08	2.73	3.08	2.73	2.56		3.36	3.55	3.73 4.10
59.5	59.3	14.6	42.2	5.5	4.0	F78-14	20	3.08	2.73	3.08	2.73	2.56		3.36		
59.5	58.3	14.6	42.2	5.5	4.0	F78-14	20	3.08	2.73	3.08	2.73	2.56		3.36		
63.6	62.7	18.5	42.5	5.8	3.1	F78-15	25	3.08	2.73	3.08	2.73	2.56	2.29	3.36		
59.5	58.3	14.6	42.2	5.5	4.0	G78-15	20	NA	NA	3.08	2.73	2.56		3.36		
48.8			37.0	3.45	3.0	F70-15	20	NA	NA	3.36	3.08	2.73		3.55	3.70	4.11
63.3	63.4	22.0	44.3	5.8	3.5	H78-15	24	NA	NA	3.23	2.76					
57.2	57.2	14.0	37.8	5.3	3.5	D78-14	18	3.23	2.76	3.23	2.76			3.55	3.91	
56.9	55.0	8.0	39.9	5.3	3.5	E70-14	18	3.23	2.76	3.23	2.76			3.55	3.91	4.10
60.6	60.4	17.4	40.9	5.3	3.5	F78-14	19	3.23	2.93	2.94	3.23	2.45		3.55	3.91	4.10
60.6	60.4	11.4	40.9	5.3	3.5	F78-14	19	3.23	2.93	2.94	3.23	2.45		3.55	3.91	4.10
63.3	63.4	22.1	43.5	5.8	3.5	H78-15	24	NA	NA	3.23	2.76			3.55		
53.7	46.1	10.4	35.6	5.2	NA	B78-14	16	2.83	3.08	NA	NA			3.20		
59.5	59.5	12.2	39.8	5.25	3.5	E78-14	16	3.08	2.83	2.79	2.79			3.00		
55.6	51.3	8.3	37.6	4.46	3.59	E78-14	22	3.08	2.83	2.79	2.79			3.00	3.25	3.50 3.91 4.30
59.0	59.2	16.2	41.45	5.0	3.5	E78-14	20	3.00	2.79	2.79	2.79			3.00	3.25	3.50 3.91 4.30
62.3	62.3	18.0	42.3	5.64	4.0	F78-15	24.1	3.07	2.75	3.07	2.75			3.25		
59.2	56.8	12.8	42.7	NA	4.0	215R-15	24.1	NA	NA	NA	2.75			3.25		
58.1	58.0	12.8	43.4	NA	4.0	215R-15	24.1	NA	NA	NA	2.75			3.25		
55.0	54.2	11.2	36	5.9	3.2	B78-14	20	3.08	3.08	NA	2.87			3.15		
63.0	62.9	17.2	44.9	NA	3.5	L84-15	24	NA	NA	NA	2.94					
57.6	56.4	10.2	36.3	5.0	3.2	E78-14	19	3.08	3.08	3.15	2.87			3.54	3.91	
62.3	62.3	19.1	46.7	NA	3.7	9.15-15	24	NA	NA	NA	2.80			3.00		
58.3	60.4	13.5	42.0	NA	3.7	225R-15	24	NA	NA	NA	2.80			3.00		
55.2	52.4	10.1	39.2	4.5	3.6	E78-14	20	NA	NA	2.75	2.75			3.00	3.25	3.50 3.91 4.30
59.0	59.2	16.2	41.45	5.0	3.5	E78-14	22	3.00	2.79	2.79	2.79			3.00	3.25	3.50 3.91 4.30
59.0	58.0	16.2	41.45	5.0	3.5	F70-14	22	NA	NA	3.00	2.75			3.25	3.50	3.91 4.30
62.3	62.3	20.6	42.8	5.64	4.0	G78-15	24.1	NA	NA	3.00	2.75			3.25		
62.3	61.1	18.0	42.2	5.64	4.0	H70-15	24.1	NA	NA	3.00	2.75			3.25		
62.3	62.3	20.6	42.8	5.64	4.0	H78-15	24	NA	NA	3.00	2.75			3.25		
59.5	59.3	17.0	42.1	5.56	4.3	G78-14	20	2.78	2.78	3.08	2.78	2.56		3.23	3.42	3.91 4.33
59.7	58.3	17.0	40.0	5.56	4.3	G78-14	20	2.78	2.78	3.08	2.78	2.56		3.23	3.42	3.91 4.33
63.8	63.5	19.5	45.4	5.5	3.8	H78-15	25	NA	NA	3.23	2.78	2.56		2.93		
63.5	62.6	20.5	46.9	NA	3.8	J78-15	25	NA	NA	NA	2.56					
62.3	55.6	14.6	42.75	NA	3.4	J78-15	24	NA	NA	NA	3.07					
57.2	57.2	14.5	37.8	5.3	3.5	C78-14	18	3.23	2.76	3.23	2.76			3.55	3.91	
57.1	52.0	5.9	38.7	5.37	3.5	E78-14		3.23	2.76	3.23	2.76	2.45		3.55	3.91	4.10
60.4	60.4	15.9	40.6	5.3	3.5	F78-14	19	3.23	2.93	2.94	2.71			3.55	3.91	4.10
63.3	63.4	21.5	42.8	5.8	3.5	G78-15	24	3.23	3.23	3.23	2.71			3.55		
56.3	47.3	11.1	38.5	4.8	2.45	F78-14	18.5	3.23	3.08	3.08	3.08	2.56	2.78	3.90	4.33	
59.8	57.2	14.6	38.6	5.6	3.5	G78-14	21.5	3.23	3.08	3.55	3.55	2.56	2.78	3.90	4.33	
59.7	56.9	14.6	37.4	5.6	3.5	G78-14	21.5	3.23	3.08	3.55	3.55	2.56	2.78	3.90	4.33	
63.8	63.5	19.6	42.8	5.6	3.5	H78-15	26	NA	NA	3.23	2.93	2.41	2.56	3.42		
61.8	62.0	21.8	43.7	5.6	3.5	H78-15	26	NA	NA	3.23	2.93	2.41	2.56	3.42		
57.5	52.7	15.3	39.3	5.6	3.5	G78-14	21.5	NA	NA	3.23	2.93	2.78		3.31	3.55	
60.3	60.4	18.0	37.8	6.0	3.2	E78-14	16	3.15	3.15	NA	2.87			3.54		

he dimensions refer to the coupe or hardtop.

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Facts and Figures on the '70 Cars—Engines

MAKE	ENGINE TYPE	DISPLACEMENT (cu. in.)	BORE & STROKE (in.)	COMP. RATIO	FUEL	CARBURETION		VALVE LIFTER
AMERICAN MOTORS CORPORATION	OHV 6	199	3.75x3.00	8.5	Reg.	Holley	1 bbl.	Hydr.
	OHV 6	232	3.75x3.50	8.5	Reg.	Holley	1	Hydr.
	OHV 6	232	3.75x3.50	8.5	Reg.	Carter	2	Hydr.
	OHV V-8	304	3.75x3.44	9.0	Reg.	Carter	2	Hydr.
	OHV V-8	360	4.08x3.44	9.0	Reg.	Carter	2	Hydr.
	OHV V-8	360	4.08x3.44	10.0	Prem.	Carter	4	Hydr.
	OHV V-8	390	4.17x3.57	10.0	Prem.	Carter	4	Hydr.
BUICK	OHV 6	250	3.875x3.53	8.5	Reg.	Rochester	1	Hydr.
	OHV V-8	350	3.80x3.85	9.0	Reg.	Rochester	2	Hydr.
	OHV V-8	350	3.80x3.85	9.0	Reg.	Rochester	4	Hydr.
	OHV V-8	350	3.80x3.85	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.3125x3.90	10.0	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.3125x3.90	10.0	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.3125x3.90	10.0	Prem.	Rochester	4	Hydr.
CADILLAC	OHV V-8	472	4.30x4.06	10.0	Prem.	Rochester	4	Hydr.
	OHV V-8	500	4.30x4.304	10.0	Prem.	Rochester	4	Hydr.
CHEVROLET	OHV 4	153	3.875x3.25	8.5	Reg.	Rochester	1	Hydr.
	OHV 6	230	3.875x3.25	8.5	Reg.	Rochester	1	Hydr.
	OHV 6	250	3.875x3.53	8.5	Reg.	Rochester	1	Hydr.
	OHV V-8	307	3.875x3.25	9.0	Reg.	Rochester	2	Hydr.
	OHV V-8	350	4.00x3.48	9.0	Reg.	Rochester	2	Hydr.
	OHV V-8	350	4.00x3.48	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	350	4.00x3.48	11.0	Prem.	Rochester	4	Hydr.
	OHV V-8	396	4.094x3.76	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	396	4.094x3.76	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	400	4.126x3.76	10.25	Prem.	Rochester	2	Hydr.
	OHV V-8	400	4.126x3.76	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	427	4.251x3.76	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	427	4.251x3.76	10.25	Prem.	3 Holley	2	Hydr.
	OHV V-8	427	4.251x3.76	11.0	Prem.	3 Holley	2	Mech.
	OHV V-8	454	4.251x4.00	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	454	4.251x4.00	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	454	4.251x4.00	10.25	Prem.	Rochester	4	Hydr.
CHRYSLER CORPORATION	OHV 6	198	3.40x3.64	8.4	Reg.	Carter	1	Mech.
	OHV 6	225	3.40x4.12	8.4	Reg.	Holley	1	Mech.
	OHV V-8	318	3.91x3.31	8.8	Reg.	Carter	2	Hydr.
	OHV V-8	340	4.04x3.31	10.5	Prem.	Carter	4	Hydr.
	OHV V-8	383	4.25x3.38	8.7	Reg.	Holley	2	Hydr.
	OHV V-8	383	4.25x3.38	9.5	Prem.	Carter	4	Hydr.
	OHV V-8	383	4.25x3.38	10.0	Prem.	Holley	4	Hydr.
	OHV V-8	426	4.25x3.75	10.25	Prem.	2 Carter	4	Hydr.
	OHV V-8	440	4.32x3.75	10.5	Prem.	Carter	4	Hydr.
	OHV V-8	440	4.32x3.75	9.7	Prem.	Carter	4	Hydr.
	OHV V-8	440	4.32x3.75	10.1	Prem.	3 Holley	2	Hydr.
FORD MOTOR COMPANY	OHV 6	170	3.50x2.94	8.7	Reg.	Carter	1	Hydr.
	OHV 6	200	3.68x3.13	8.8	Reg.	Carter	1	Hydr.
	OHV 6	240	4.00x3.18	9.2	Reg.	Carter	1	Hydr.
	OHV 6	250	3.68x3.91	9.0	Reg.	Carter	1	Hydr.
	OHV V-8	302	4.00x3.00	9.5	Reg.	Autolite	2	Hydr.
	OHV V-8	302	4.00x3.00	10.5	Prem.	Autolite	4	Mech.
	OHV V-8	351	4.00x3.50	9.5	Reg.	Autolite	2	Hydr.
	OHV V-8	351	4.00x3.50	10.7	Prem.	Autolite	4	Hydr.
	OHV V-8	390	4.05x3.78	9.5	Reg.	Autolite	2	Hydr.
	OHV V-8	390	4.05x3.78	10.5	Prem.	Autolite	2	Hydr.
	OHV V-8	428	4.13x3.98	10.6	Prem.	Holley	4	Hydr.
	OHV V-8	429	4.36x3.59	10.5	Prem.	Autolite	2	Hydr.
	OHV V-8	429	4.36x3.59	10.5	Prem.	Autolite	4	Hydr.
	OHV V-8	429	4.36x3.59	10.5	Prem.	Rochester	4	Mech.
	OHV V-8	429	4.36x3.59	11.0	Prem.	Rochester	4	Hydr.
	OHV V-8	429	4.36x3.59	10.5	Prem.	Holley	4	Hydr.
	OHV V-8	460	4.36x3.85	10.5	Prem.	Autolite	4	Hydr.
OLDSMOBILE	OHV 6	250	3.875x3.53	8.5	Reg.	Rochester	1	Hydr.
	OHV V-8	350	4.057x3.385	9.0	Reg.	Rochester	2	Hydr.
	OHV V-8	350	4.057x3.385	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.125x4.25	9.0	Reg.	Rochester	2	Hydr.
	OHV V-8	455	4.125x4.25	10.25	Prem.	Rochester	2	Hydr.
	OHV V-8	455	4.125x4.25	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.125x4.25	10.5	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.125x4.25	10.5	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.125x4.25	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.125x4.25	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.125x4.25	10.25	Prem.	Rochester	4	Hydr.
PONTIAC	OHV 6	250	3.875x3.53	8.5	Reg.	Rochester	1	Hydr.
	OHV V-8	350	3.875x3.75	8.8	Reg.	Rochester	2	Hydr.
	OHV V-8	400	4.12x3.75	8.8	Reg.	Rochester	2	Hydr.
	OHV V-8	400	4.12x3.75	10.0	Prem.	Rochester	4	Hydr.
	OHV V-8	400	4.12x3.75	10.25	Prem.	Rochester	4	Hydr.
	OHV V-8	400	4.12x3.75	10.5	Prem.	Rochester	4	Hydr.
	OHV V-8	400	4.12x3.75	10.5	Prem.	Rochester	4	Hydr.
	OHV V-8	400	4.12x3.75	10.0	Prem.	Rochester	2	Hydr.
	OHV V-8	455	4.15x4.21	10.0	Prem.	Rochester	4	Hydr.
	OHV V-8	455	4.15x4.21	10.25	Prem.	Rochester	4	Hydr.

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HP @ R.P.M.	TORQUE	STANDARD ON	OPTIONAL ON
128 @ 4,400	182 @ 1,600	Hornet	
145 @ 4,300	215 @ 1,600	Javelin, Rebel	Hornet
155 @ 4,400	222 @ 1,600	Ambassador	Hornet, Rebel
210 @ 4,400	305 @ 2,800	Ambassador DPL & SST	Hornet, Javelin, Rebel, Ambassador
245 @ 4,400	365 @ 2,400		Javelin, Rebel, Ambassador
290 @ 4,800	395 @ 3,200	AMX	Javelin, Rebel, Ambassador
325 @ 5,000	420 @ 3,200		Javelin, AMX, Rebel SST, Ambassador DPL & SST
155 @ 4,200	235 @ 1,600	Skylark	
260 @ 4,600	360 @ 2,600	Skylark, Le Sabre	
285 @ 4,600	375 @ 3,000		Skylark, Le Sabre
315 @ 4,800	410 @ 3,200	Skylark GS	Skylark, Le Sabre
350 @ 4,600	510 @ 2,800		Skylark GS
360 @ 4,600	510 @ 2,800		Skylark GS
370 @ 4,600	510 @ 2,800	Wildcat, Electra 225, Riviera	Le Sabre
375 @ 4,400	525 @ 3,000	Calais, de Ville, Fleetwood	
400 @ 4,400	550 @ 3,000	Eldorado	
90 @ 4,000	152 @ 2,400	Nova	
140 @ 4,400	220 @ 1,600	Nova, Camaro	
155 @ 4,200	235 @ 1,600	Chevelle, Chevrolet	Nova, Camaro
200 @ 4,600	300 @ 2,400	Nova, Camaro, Chevelle	
250 @ 4,800	345 @ 2,800	Chevrolet, Monte Carlo	Nova, Camaro, Chevelle
300 @ 4,800	380 @ 3,200	Corvette	Nova SS, Camaro SS, Chevelle, Chevrolet, Monte Carlo
350 @ 5,600	380 @ 3,600		Corvette
325 @ 4,800	410 @ 3,200		Camaro SS
350 @ 5,200	415 @ 3,400		Chevelle SS
265 @ 4,400	400 @ 3,200		Chevrolet, Monte Carlo
330 @ 4,800	410 @ 3,600		Chevelle, Monte Carlo
390 @ 5,400	460 @ 3,600		Corvette
400 @ 5,400	460 @ 3,600		Corvette
435 @ 5,800	460 @ 4,000		Corvette
345 @ 4,800	500 @ 3,200		Chevrolet
360 @ 5,200	500 @ 3,600		Monte Carlo, Chevelle
390 @ 5,200	500 @ 3,600		Chevrolet
125 @ 4,400	180 @ 2,000	Valiant, Duster, Dart	
145 @ 4,000	215 @ 2,400	Barracuda, Belvedere, Fury, Challenger, Coronet, Charger	Valiant, Duster, Dart
230 @ 4,400	320 @ 2,000	Dart, Valiant, Duster, Barracuda, Belvedere, Fury, Polara, Charger, Coronet, Challenger	
275 @ 5,000	340 @ 3,200		Valiant, Duster, Dart
290 @ 4,400	390 @ 2,800	Chrysler, Monaco	Barracuda, Belvedere, Fury, Challenger
330 @ 5,000	425 @ 3,200		Barracuda, Belvedere, Fury, Chrysler, Coronet, Challenger, Charger
335 @ 5,200	425 @ 3,400		Barracuda, Challenger R·T
425 @ 5,000	490 @ 4,000		Barracuda, Belvedere, Challenger, Coronet, Charger
375 @ 4,600	480 @ 3,200		Belvedere, Fury, Coronet, Polara, Monaco, Chrysler
350 @ 4,400	480 @ 2,800	Imperial	Barracuda, Belvedere, Fury, Chrysler, Coronet R·T, Challenger
390 @ 4,700	480 @ 3,600		Barracuda, Belvedere, Fury, Coronet R·T, Charger R·T, Challenger
105 @ 4,200	156 @ 2,200	Maverick	
120 @ 4,000	190 @ 2,200	Falcon, Mustang	
150 @ 4,000	234 @ 2,200	Ford	
155 @ 4,000	240 @ 1,600	Torino, Montego	
220 @ 4,600	300 @ 2,600	Ford, Torino, Falcon, Mustang, Montego	
290 @ 5,800	290 @ 4,300		Mustang, Cougar
250 @ 4,600	355 @ 2,600	Cougar	Mustang, Torino, Ford, Montego
290 @ 4,800	385 @ 3,200		Mustang, Torino, Montego, Cougar
265 @ 4,400	390 @ 2,600	Mercury	Ford
280 @ 4,400	403 @ 2,600		Mercury
335 @ 5,200	440 @ 3,400		Mustang, Cougar
320 @ 4,400	460 @ 2,200		Ford, Mercury
360 @ 4,600	480 @ 2,800	Thunderbird	Torino, Ford, Mercury, Montego
NA	NA		Torino, Montego
365 @ 4,600	440 @ 2,800		Torino, Montego, Cougar
375 @ 5,200	450 @ 3,400		Mustang, Torino, Montego
365 @ 4,600	500 @ 2,800	Lincoln Continental, Continental Mark III	
155 @ 4,200	235 @ 1,600		
250 @ 4,400	355 @ 2,600	Delta 88	
310 @ 4,800	390 @ 3,200		
310 @ 4,200	490 @ 2,400		Delta 88
320 @ 4,200	500 @ 2,400		
365 @ 4,600	510 @ 3,000	98	
365 @ 5,000	500 @ 3,200	4-4-2	Delta 88
370 @ 5,400	500 @ 3,600		4-4-2
390 @ 5,000	500 @ 3,200		Delta 88
375 @ 4,600	500 @ 3,000	Toronado	
400 @ 5,200	500 @ 3,200		Toronado
155 @ 4,200	235 @ 1,600	Tempest, LeMans, Firebird	
255 @ 4,600	355 @ 2,800	Catalina, Bonneville, Executive	
265 @ 4,600	397 @ 2,400		Tempest, LeMans, Catalina, Executive, Bonneville, Grand Prix, Firebird
330 @ 4,800	445 @ 2,900		Tempest, LeMans, Catalina, Executive, Bonneville, Firebird
350 @ 5,000	445 @ 3,000	Tempest, LeMans, Grand Prix, GTO, Firebird	
366 @ 5,100	445 @ 3,600		Tempest, LeMans, GTO, Firebird
370 @ 5,500	445 @ 3,900		Tempest, LeMans, GTO, Firebird
290 @ 4,600	428 @ 2,500		Catalina, Executive, Bonneville
360 @ 4,300	500 @ 2,700		Catalina, Executive, Bonneville, Tempest, LeMans, GTO
370 @ 4,600	500 @ 3,100		Catalina, Executive, Bonneville, Grand Prix

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Taking a high-speed turn, the Monte Carlo coupe stays almost flat, with near-neutral handling.

Chevy's MONTE CARLO

Easy-to-read instruments are set in a rich simulated wood-burl panel. An electric clock is standard equipment. The flow-through ventilation system has vent ports on the instrument panel—doors have no vent windows. Wiper-and-washer button is carried on end of turn signal stalk for ease of operation. Automatic locks for seat backs (they unlock when engine is switched off and door is open) are optional.

Chevy branches out with a new top-line personal luxury car that looks like a winner

The idea of the personal-luxury car came from Ford, and the Thunderbird has had 10 very successful years. Buick's Riviera failed to put a dent in T-bird sales, and the Toronado did no better. Last year it was Pontiac's turn to try, with the Grand Prix. It has given the T-bird such a hard time that Ford has restyled its car completely for '70. But GM also gave Chevrolet the go-ahead for its own personal-luxury car, launching a two-front attack on the traditional leader in this field.

Now that you know the background to the Monte Carlo, you will not be surprised to hear that it shares the G body with the Grand Prix. Interior space compares with the Chevelle's, but the hood is the longest in Chevrolet history.

The most striking thing about your first ride in the Monte Carlo is the quietness of the car. Suspension anchorage points and body mounts have generous rubber insulation, and the whole interior has premium-quality trim and appointments. Sheet-metal panels are covered

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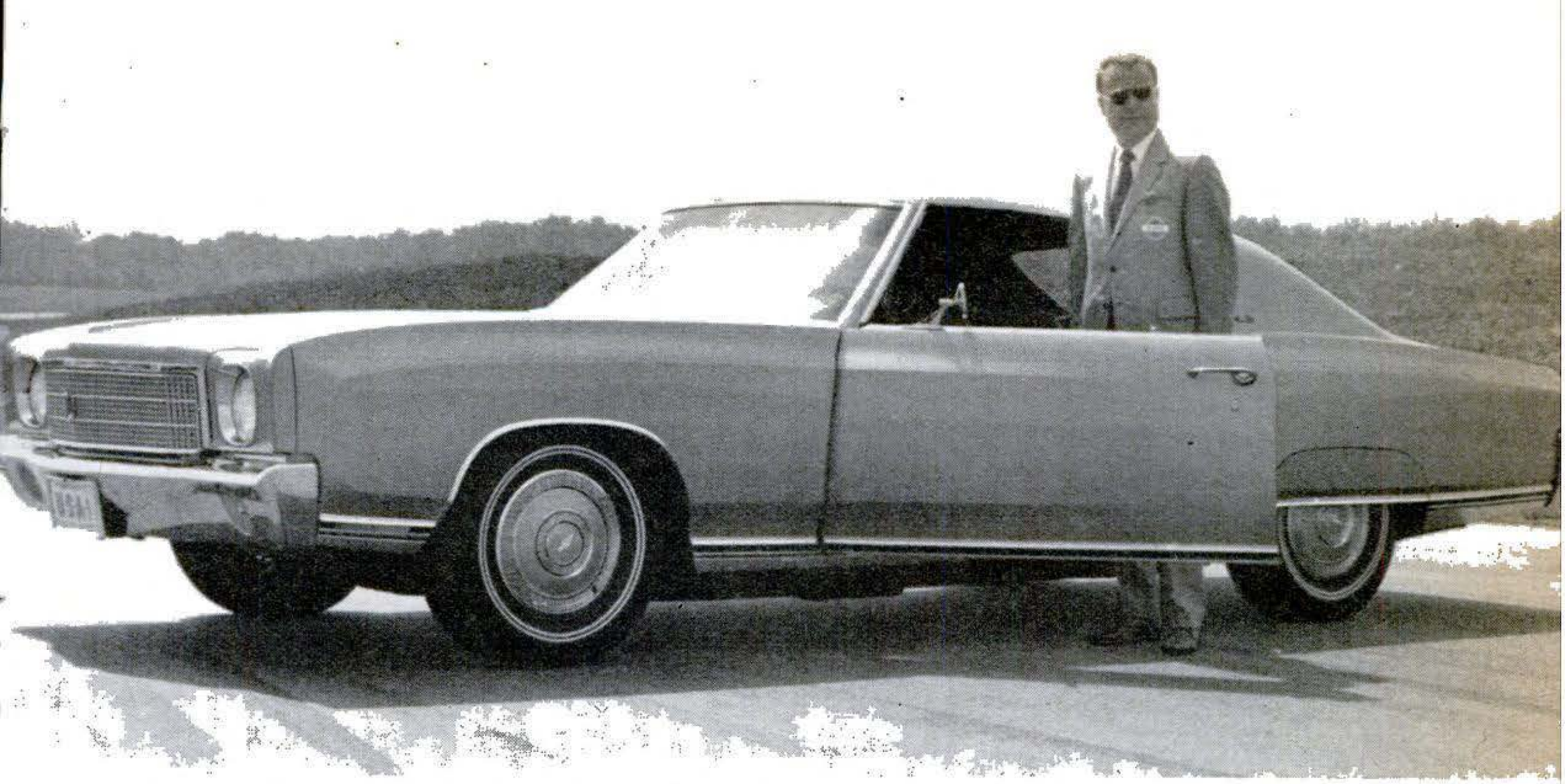


Only one body style is available—a hardtop coupe. The vinyl roof is an inexpensive option.

Tackles the T-Bird

with several layers of sound-deadening materials of various types. Floors are covered with deep-twist carpeting, and both front and rear seats have extra-thick foam cushioning. Would you have believed five years ago that Chevrolet would ever produce such a dream car? Well, here it is, and Chevrolet spokesmen have hinted at a price tag around $3,600—more than $1,000 below the Thunderbird price level.

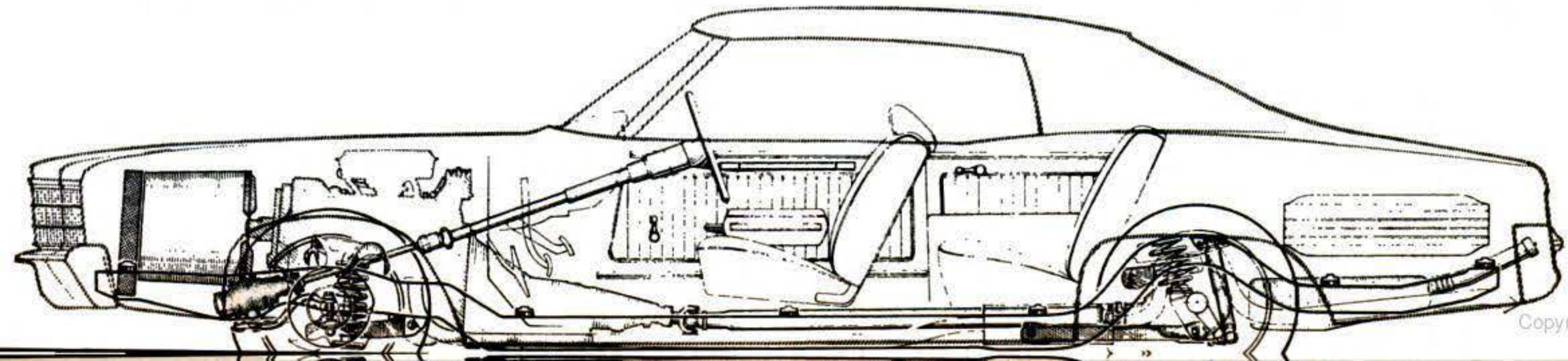
Standard equipment includes power brakes (disk front), 15-inch wheels, and full coil suspension with computer-selected springs. Variable-ratio power steering and tilting wheel are commendable options. Monte Carlo SS equipment includes dual exhausts, special chassis components, wide-rim wheels, and automatic level control.

Power for the Monte Carlo? Standard engine is a 250-hp. 350-cubic-inch V-8. Top option is a 330-hp. 400-cubic-inch V-8. All engines are available with four-speed floorshifts or Turbo-HydraMatic transmission.

The engine sits well back in the frame, giving the car excellent weight distribution. Although response to the helm is precise and fast, the car's stability on curves is outstanding. We hit the brakes —hard—on a 400-foot-radius turn at 60 m.p.h. and the car stopped, holding to the chosen line without any need for steering corrections. On sharp turns and switchback roads the Monte Carlo is predictable and forgiving. It understeers, much as the Camaro does.

Summing up, while the Monte Carlo is no doubt one of the auto industry's best-suited cars for elegant high-speed travel, its short (116 inches) wheelbase and modest width make it attractive also for city-and-suburban driving.

Front seating space is remarkably generous, but the rear-seat passengers have no more room than in a Chevelle, even though they ride in higher-grade, more comfortable, and better-padded seats.



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Ventless front windows, flush-fitting door handles, wraparound taillights, low belt line, and a large glass area are probably the first things you will notice on the Hornet. Both the four-door model (top and center) and the two-door SST shown here have optional vinyl roofs. A station-wagon body may be added to the Hornet line as a 1970½ model, but no convertible has been planned.

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Rambler Is Dead– Long Live the HORNET

American Motors' new economy car is same size and basic price as Maverick—but has more to offer

The all-new Hornet takes the place of the defunct Rambler (ex-American) in the '70 car line from American Motors. It is low, wide, and handsome where the Rambler was tall, narrow, and ordinary. It has modern proportions, with a long hood and a short deck, whereas the Rambler was just plain boxy. The Hornet also has a windshield rake that's as sharp as anything you can find on a sports car. Overall, the package is extremely clean and attractive.

The Hornet's direct competition is Ford's Maverick [PS, April]. It comes in more versions, with many more options, though a four-speed floorshift is not to be had at any price on either car. To pinpoint differences:

- The Hornet has two- and four-door bodies; Maverick is two-door sedan only.
- The Hornet has an optional V-8 engine; sixes only in Maverick.
- Variable-ratio power steering is available on the Hornet; manual steering only on Maverick.
- Power brakes (drums only) are optional on the Hornet; unavailable on Maverick.
- American Motors offers a "handling package" for the Hornet; Ford has none for the Maverick.
- The Hornet has more head room, leg room, and hip room front and rear than Maverick—it even has a glove box; Maverick has only a shelf.

What's it like to drive? Ride comfort is okay, and road noise and vibration are pretty well filtered out of the unit-construction body. The car handles far better than the Rambler, mainly thanks to its new front suspension. The roll center is raised, considerably reducing the understeering tendency without causing any loss of directional stability.

It's still no sports car, but it's certainly superior among economy cars in the ride-and-handling department. On performance, it's way ahead. A 210-hp. 304-cubic-inch V-8 is optional in the Hornet SST. The standard (basic) engine is a 128-hp. 199-cubic-inch six (against 105 hp. and 170 cubic inches in the Maverick), and the optional six is a 232-cubic-inch unit rated at 145 hp. with a one-barrel carb, or 155 hp. with a two-barrel carb. (The Maverick's top power option is a 120-hp. 200-cubic-inch six).

Transmissions for the Hornet are a three-speed column-shift (standard) and the Shift-Command—Borg-Warner's three-speed automatic (optional).

Will the Hornet put American Motors back on the road to success? Time will answer that one, but here's what we think: How can the Hornet possibly fail?

Enormous front-door opening offers you great ease of entry and exit, but rear-seat passengers aren't that lucky. Inside space, however, is quite ample.

Trunk capacity, despite the short deck lid, is fairly generous. The spare wheel is stored at front of the trunk in the right-hand corner, covering the tools.

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Dodge Brings Out a Hot New

Dodge's interior stylists strove for an aerospace theme in designing the cockpit. Major controls have a tough-car feel to them, as in a hot Charger.

Dodge is the last car maker to produce an anti-Mustang, but this one must be taken seriously

No, no, this is not just another "pony car," as the Mustang and its imitations are often referred to by car buffs.

What sets it apart? It goes right down to the basic components. Up to now, these cars have been based on compacts. The Mustang stemmed from the Falcon, the Camaro from the Chevy II, and the Barracuda from the Valiant. But the Challenger is not a warmed-over Dart with a low center of gravity. It has its own, entirely new body, and the entire running gear is shared with the Charger, i.e., an intermediate-size car. For this,

Challenger comes in two body styles: two-door hardtop and convertible. The hardtop has a rollover bar formed as an integral part of the unit body, not unlike the Corvette's arrangement. The R/T hood (below) has a power bulge and dummy air intakes, but an exposed "shaker" scoop is available for Challengers with the Six-Pak 440 and dual four-barrel 426 hemihead engines. In drawing on opposite page you can see mechanical elements of the Challenger with the V-8 engine and floorshift.

Sportster: CHALLENGER

naturally, there is a weight penalty—but think of the tough Charger transmissions and axles, and you'll be glad you have them. For the power options listed for this Challenger are really fantastic.

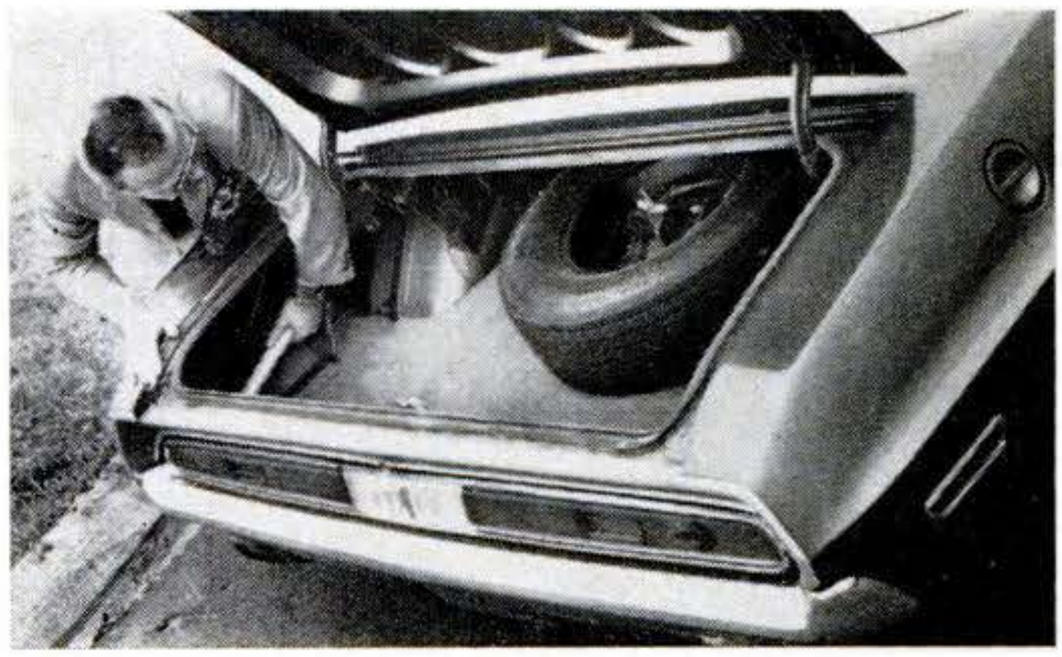
You can get a 440-cubic-inch V-8 with three two-barrel downdraft Holleys that delivers 390 hp. and pulls like a team of elephants from about 1,100 r.p.m. on up. Or you can go all the way and get the famous hemi, equipped with dual four-barrel Carters, rated at 425 hp. Now this is a great engine for acceleration, but it doesn't like to run at steady, slow speeds. Note that the production hemis now come through with hydraulic valve lifters. They cut engine noise by giving better control of valve lash and camshaft overlap—and reduce the risk of over-revving.

The basic V-8 is the 318 economy engine, and the standard six is Chrysler Corporation's old reliable four-bearing 225-cubic-inch slant-six. The 340-cubic-inch high-performance V-8 is the obvious choice for the man who doesn't want a big gas-eater but won't skimp on power.

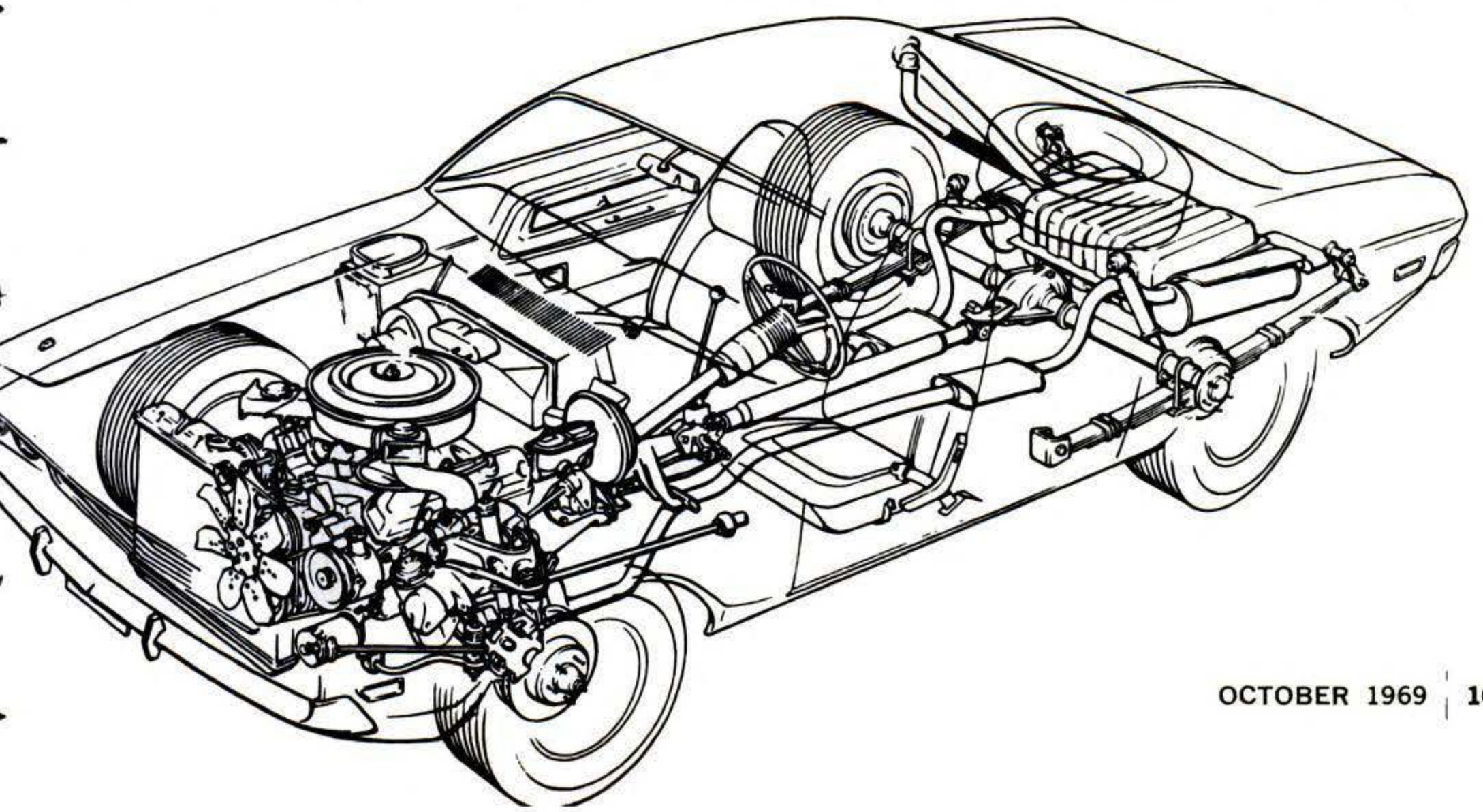
You may have noticed in the photos that the Challenger has American Motors-type door handles. That's outside and that's fine. But the interior locks look as if they belong on an AMC car, too, being recessed in the armrest, instead of following the now-accepted Chrysler design. We find these locks inconvenient in use, and they feel fragile.

The Challengers we drove were not very quiet on the road, with unit-construction bodies, stiff suspension, and very wide sports tires. If you're more interested in ride comfort than in handling, stay away from the heavy V-8s and the springing that goes with them. On the other hand, the suspension system on the hottest Challengers proved capable of handling the enormous torque loads of full-throttle acceleration, and of keeping the car in a stable attitude on straightaways and curves alike. If you want a hot-rod that handles, you might find the Challenger R/T just perfect.

With its well-tried mechanical elements, the Challenger has needed less development than other new cars, and it should be free of bugs. There must be lots of you enthusiasts out there just waiting for a car like this.



Challenger trunk is small, though no worse than on other cars in its category. Tool position is good; optional Space-Saver tire gives extra storage room.



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The 1970 Cars

Now Detroit offers you more different types of cars than ever before, tailored to special needs the "standard" car can't meet

By **JAN P. NORBYE** / *PS Automotive Editor*
and **JIM DUNNE** / *PS Detroit Editor*

If yours is one of the 15 million multicar families in America, you'll profit by considering the jobs your cars must do — before choosing them. Different loads and operating conditions call for different cars. In the full-color pages that follow, we'll look at what's available for '70—and spark your imagination with some suggestions for multicar combinations. Think about your family's transportation needs and try to find the best types of cars for them. Choose from station wagons and personal-luxury cars, sporty cars and economy cars, off-road four-wheel-drive workhorse vehicles and small boxy buses. Pick 'em right, and you'll get things done easier and have more fun. The right car for the right job will bring running costs down and cut repair bills.

Mustang, Bronco, and Country Squire

For a family that sticks with Ford products, the Mustang Grande (front) takes care of commuting and weekend trips for two. The new formal roof gives it a "town-car" look. The Country Squire (center, right) is for longer trips, for shopping, and for outings with guests. It's great for trailer-towing. The 4 x 4 Bronco (center, left) goes fishing in the summer, snow-plowing in the winter, and does odd jobs throughout the year. Optional equipment includes towing package, power take-off, and free-wheeling front hubs.

1970

Chevrolet Blazer, Nova, and Monte Carlo

These three Chevy models fill the varied transportation needs of this suburban family. The four-wheel-drive Blazer (above) is used as a utility car, both on and off the highway. The Nova (rear) is Hers, an everyday

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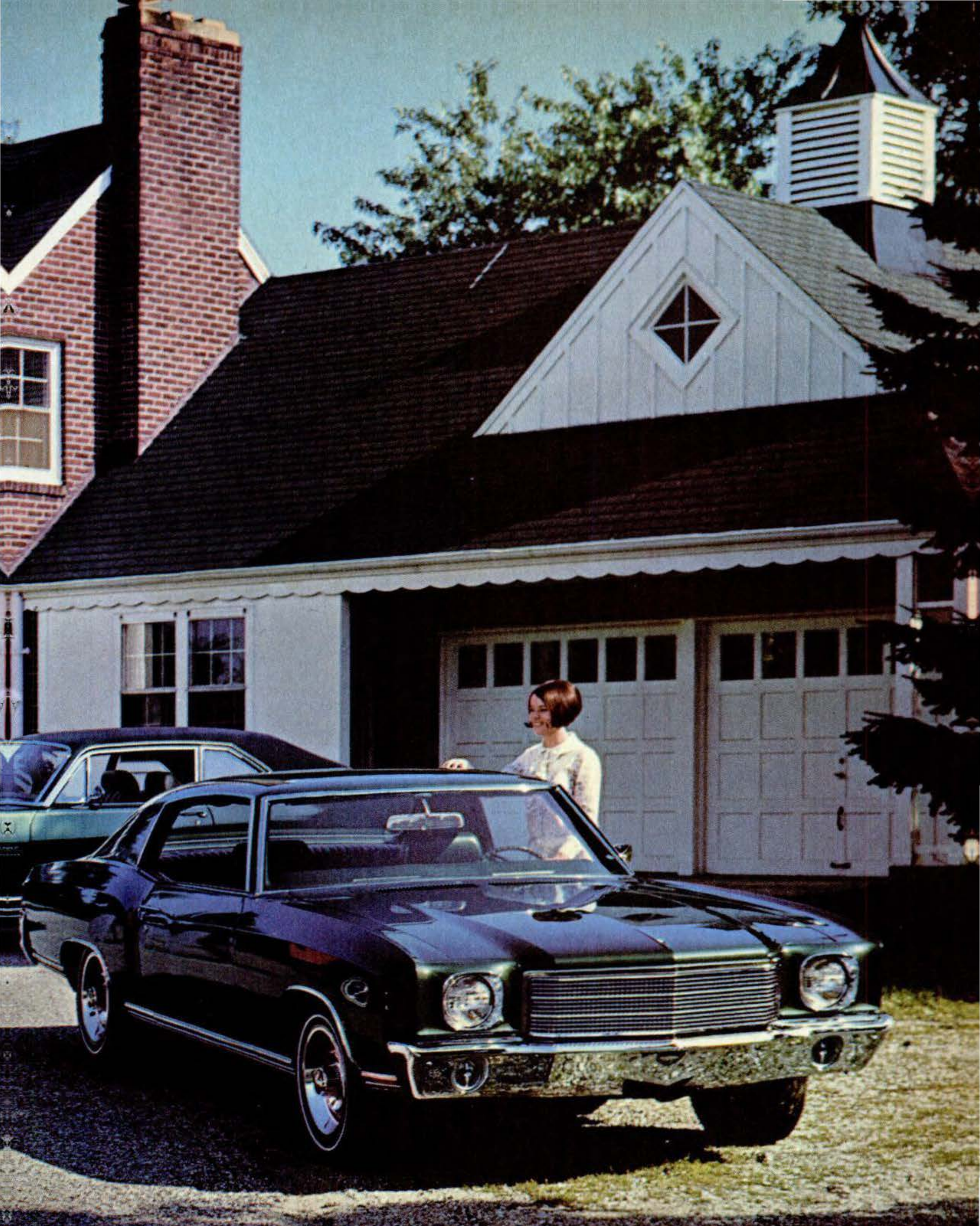

all-purpose economy car. The all-new Monte Carlo (above) is His — his car for business trips, and the Number One family car for weekends and evenings. For a detailed description of the Monte Carlo, see our story on page 104.

Plymouth Duster and Chrysler wagon

New Duster (front) teams up with Chrysler's big Town and Country wagon (rear) to handle a variety of duties. She uses the wagon for school-bussing and shopping during the week, when he's on the road with the Duster (special hardtop coupe based on the Valiant). On weekends, he drives the wagon, with the whole family on board. For full data on the power teams available in both, see the specification charts on pages 100-103.

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Pontiac Catalina wagon and Firebird

Partial to Pontiac products, this family runs a Catalina wagon (front) and a Firebird (rear). He gets a special satisfaction from commuting in a sporty car, and as long as the children are small, the Firebird can carry the whole family for short trips. The wagon is the family's jack-of-all-trades. It goes to the supermarket and it goes on vacation trips.

Maverick, Club Wagon, and Thunderbird

Another all-Ford family has chosen the eight-seater Club Wagon (rear) for its utility vehicle. It also takes the whole family and guests on short weekend trips. The four-door Thunderbird Landau (right) is the basic family car, and the student of the house drives the Maverick (left). New Thunderbird features for '70 include hideaway wipers, radio antenna that sandwiches into the windshield, and B. F. Goodrich all-rayon radial-ply tires.

1970

Skylark wagon, Opel, and Riviera

Our Buick-Opel-family housewife drives the Skylark wagon (left in photo) while the master of the house commutes in the Riviera (right). Junior goes to college and everywhere else in his Opel Kadett (center).

Lincoln and Cougar

A personal car for the lady of the house: Cougar (front, above). The true family car in this family setup is the Lincoln Continental (rear). The Continental now has separate body and frame construction.

Barracuda and Imperial

For this young, affluent, active couple, dealing only with a Chrysler-Plymouth dealer, the new Barracuda (front) plays the part of a "fun" car, while the Imperial (rear) handles all practical transportation jobs.

Hornet, Ambassador wagon, and Javelin

For this family, sold on American Motors products, the Hornet (left in photo) is the everyday car of the lady of the house. The boss commutes in Javelin (right), and they go on trips in the Ambassador wagon (rear).

Sportsman, Challenger, and Simca

Dodge's new Challenger (center — see detailed description on page 108) finds well-matched stablemates in the Dodge Sportsman A-108 eight-seater wagon (left) and the front-wheel-drive Simca 1204 economy sedan (right).

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GREAT LAKES STATE

Olds Vista-Cruiser and Toronado

An exciting two-car combination for suburban families: Oldsmobile's Vista-Cruiser station wagon (left) with its skylight-edged roof, and the front-wheel-drive Toronado (right). The Vista-Cruiser doubles as a shopping and vacation car, while the Toronado leads a double life of its own, as a business coupe all week and a luxury tourer on weekends.

GET READY FOR YOUR WINTER FUN!

By HERBERT SHULDINER

Johnson's new Skee Horses cruise down a trail at Sun Valley, Ida. The Light-Trac (front) has a 15½-inch steel-cleated track; Wide-Trac (rear), a 20½-inch track. Both are powered by 437cc., 25-hp. OMC engines.

Photo Guide to the

Is this your season to be bitten by the snowmobile bug? It may well be if you haven't already experienced the thrills of this hot, cold-weather sport.

Close to 750,000 sportsmen already own ski-scooters, ranging in price from about $400 for mini-scooters, through $700 for full-size vehicles, on up to $2,000 and more for deluxe versions. The average price is about $900.

Cold-weather enthusiasts use the machines for rallies, races, safaris, and campouts. Snowmobiles are found surprisingly far south, below what is commonly considered to be the snow belt. Another surprise: Industry sources predict that many of the 350,000 snowmobiles that are expected to be sold this winter will probably be bought by sportsmen who live in high-density suburbs and have to trailer the vehicles to places where they can be used.

The 1970 models are certain to boost enthusiasm for snowmobiles because they stack up as the sportiest, most luxurious vehicles yet to make the winter scene. More important, they are more durable and dependable than ever.

Ski-Daddler Mark VI swings around turn with its 634cc, 36-hp. Hirth engine at full throttle. It's one of AMF's four models, all newly redesigned and offering a sports-car look.

1970 Snowmobiles

A big reason for this is that snowmobiles are race-bred. Even though only a small number of snowmobiles are raced, a high proportion of sales are made on the basis of how well a snowmobile maker does on the racing circuit.

As a result, many companies spend a lot of money on factory racing teams, and build special vehicles for competition. Not only does this help them win races—it gives manufacturers a rugged testing lab for their machines.

The pounding that snowmobiles take in races, especially in the popular marathon affairs, pinpoints the parts vulnerable to breakdown. Manufacturers by now have found most of the weak spots in their products and have strengthened them, to the benefit of the user.

Now, the machines you buy have drive belts that hold up for long periods. This vital link between the en-

Continued

SnoCoupe is an elegant new snow buggy that features side-by-side seating in its fully enclosed cab. A custom-built fiberglass body is on a standard wide-track snowmobile chassis. Canopy slides off to allow entry.

Polaris Mustang is a rugged 20-inch tracked snowmobile with plenty of power. You can get it with engines ranging from 398cc to 744cc. An optional reverse gear is also available.

Mercury 250E has a bigger 437cc, 25-hp. Kiekhaefer engine for more power, and a new dual-toned exhaust and sealed muffler. It also has wider six-inch skis for better flotation.

Starcraft snowmobiles are a new entry this year, from the well-known boat maker. Starcrafts come with engines ranging from a 277cc, 15-hp. Sachs up to a 437cc, 31-hp. Kohler. The company offers nine models.

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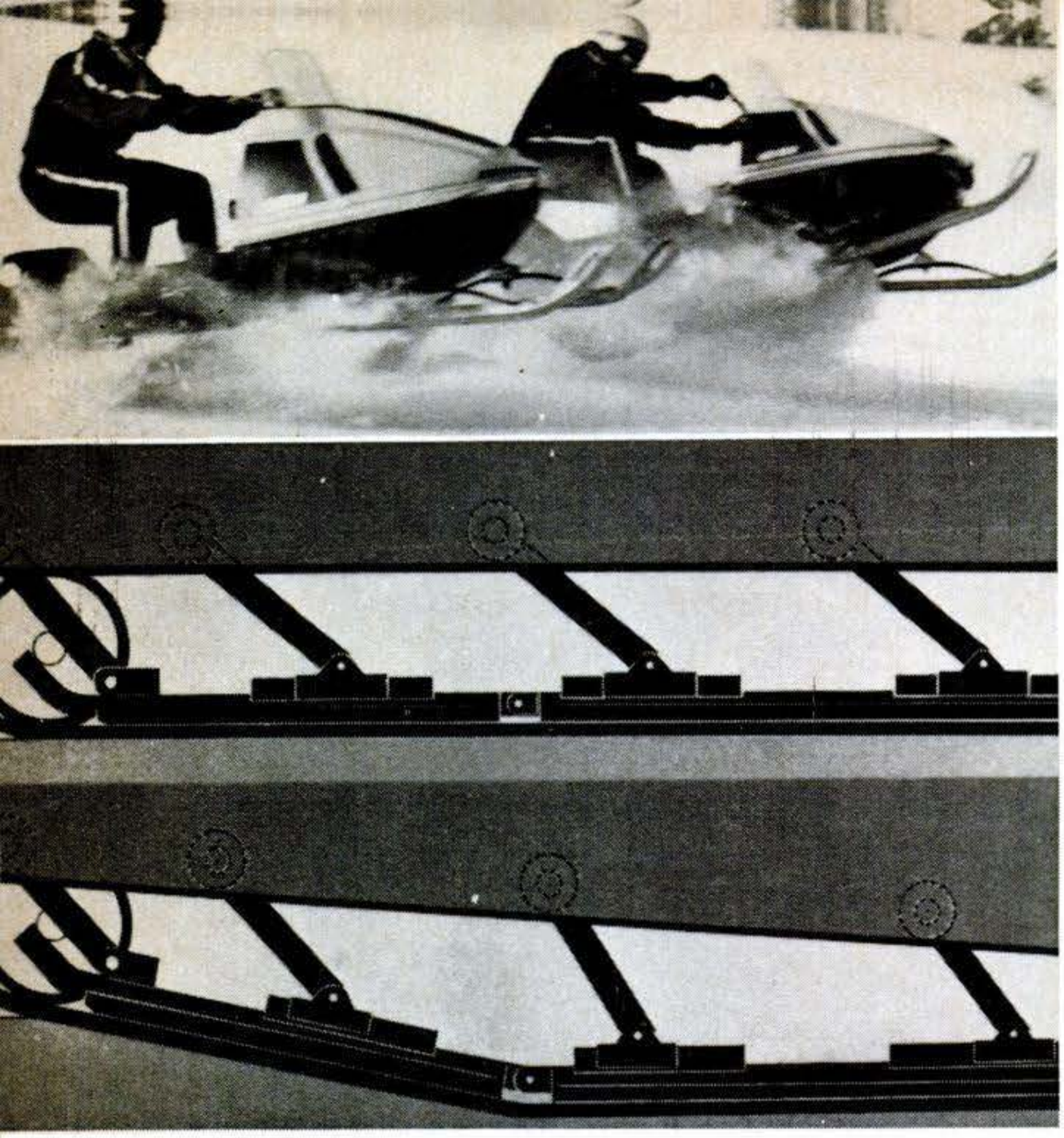

Bombardier's new slide-rail-suspension-system bottom is standard on Ski-Doo TNTs (top photo). New suspension helps racing machines maintain a better footing with their tracks, and prevents excessive bottoming.

Skiroule RTX 640 is a limited-production racing model that can be equipped with an engine of up to 793cc, putting out 60 hp. For the beginner, though, this sleek ski-scooter may be somewhat too hot to handle.

Rupp snowmobiles (shown below) feature an aluminum chassis that combines strength and light weight, to help add speed to the snow machines. The wide-tracked vehicles are fitted with 436cc, 30-hp. engines.

gine and transmission used to be extremely short-lived. Better compounds now keep belts going months longer.

The snowmobile track has also undergone an evolutionary improvement. Nylon and steel reinforcement has made tracks more durable and gives snowmobiles greater traction on all kinds of terrain.

Many a race has been lost because of a driver's inability to get quickly at parts that broke down. This has prompted snowmobile makers to produce easy-opening hoods that reveal engines and transmissions with the simple unsnapping of a couple of latches.

Improved engines. Perhaps the greatest improvement has been in engines, though. The first snowmobiles marketed had two-cycle engines that were designed for other purposes. Engine companies were skeptical about snowmobiles catching on, and didn't bother adapting their designs to the stresses of snow vehicles. But engine makers are convinced now, and are producing power plants designed for rugged use.

You get more horsepower out of the newer engines without increased displacement. And mufflers are being tuned to greater degrees of efficiency so you don't lose that new increased power.

Other advances in this year's snowmobiles include completely enclosed cabs—some with heaters—streamlined sports-car designs with air scoops, roomier and more comfortable seats, and more storage space for your winter gear.

Engineering improvements include larger gas tanks for increased cruising range, wider use of new slide-rail suspension systems instead of bogey wheels, and an increasing trend to electric-start models.

Practically all snowmobiles are powered by two-cycle air-cooled engines with outputs ranging from 12 hp. on up to 40 hp. This year, more powerful engines, including some three-cylinder brutes with displacements up to almost 800cc, are available for the speed set. Some of the three-cylinder

Continued

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vinrude's wide-tracked Skeeter makes an ideal ice-shing vehicle. It gets you way out on the lake—fast—with its 25-hp. opposed-firing, twin-cylinder OMC engine. A Sleigh-Mate trailer hauls extra gear.

ki-Whiz 300S is a new model from Massey-Fer-uson, which claims its machines have lowest center f gravity for better cornering. A front-mounted carb ncreases air intake and engine performance.

riens 400L 19-inch track gives you a balanced, table ride well suited to all-around use. It's powered y a 399cc Kohler engine that churns out 26 hp. at ,500 r.p.m. Electric starter is optional.

Alouette snowmobiles, like the XL-20E (front) and XL-26 (rear) have new safety features, including an emergency kit under the seat. Kit has a spare spark plug, belt, and pull cord for use in breakdowns.

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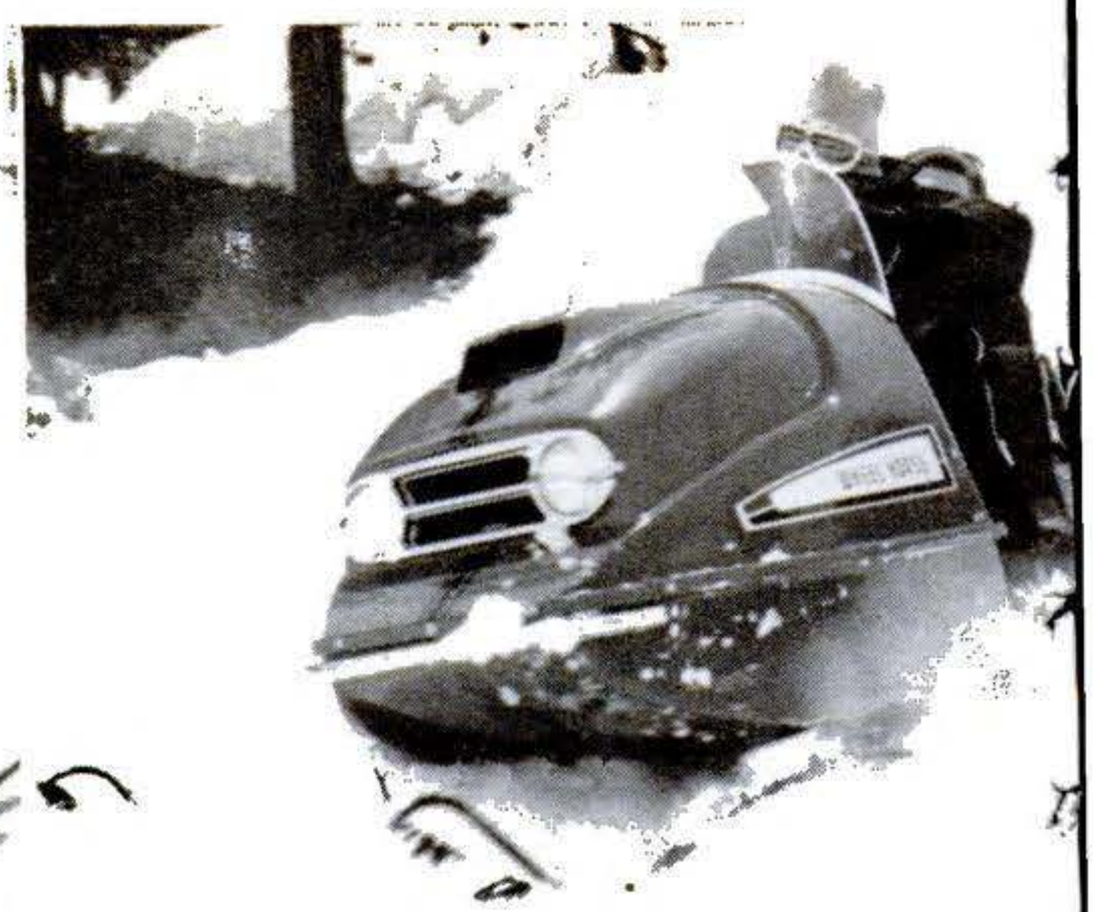

Sno-Jet is new from front to back this year. It offers a "spoiler stern," steel-and-nylon-reinforced track, and increased storage space for gear. You can get this machine with 15 different power options.

Safari above, introduced by Wheel Horse, is one six in line. Engine is placed well up in nose to ke it out of driver's lap and improve maneuverabili Kohler engines power all six Wheel Horse mode

Scorpion Stinger is a classy lightweight snowmobile with engine options up to an 800cc Sachs. Its iridescent teardrop-shaped hood flips up for extremely easy access to the engine for servicing.

Arlberg, made in Canada, is a sturdy workhors designed for all-family fun. Its optional "Troika trailer sled can easily haul a couple of kids, a b load of groceries, or lots of sporting gear.

mills are designed to propel snowmobile at speeds approaching 100 m.p.h.

Two-passenger, enclosed-cab snowmo biles will be making their luxury debu this season. They are chock full of sports car features, including fiberglass bodie and bucket seats. Unlike th large utility-type enclose oversnow vehicles that hav been around for years, thes sporty new snow buggies ar

Ridge Runner (shown at left) offer comfort-geared snowmobiling wit sporty bucket seats, enclosed canop and large baggage compartment. Twi tracked vehicle is powered by a 440c 28-hp. JLO; 744cc is optional.

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rand Prix from Moto Ski is set up for racing buffs. s available with Hirth or Sachs engines ranging om 340cc up to 634cc. The machine has a three-y rubberized track, reinforced with steel cleats.

Homelite Forester II has upped its power by 10 hp. with a 28-hp., 493cc Hirth twin-cylinder engine. The 15½-inch tracked snow vehicle offers a 12-volt electric-starter system as optional equipment.

amaha snowmobile is powered by famous motor-rcle-proved five-port engine. Japanese-made snow-obile also has Autolube pressure-lube system that ixes oil in gas, according to speed and load.

Yardman SnoCub is great fun for kids. The mini low-powered snowmobile has a top speed of less than 20 m.p.h. with a 99cc JLO engine. Two of the $400, 124-pound vehicles will fit in a station wagon.

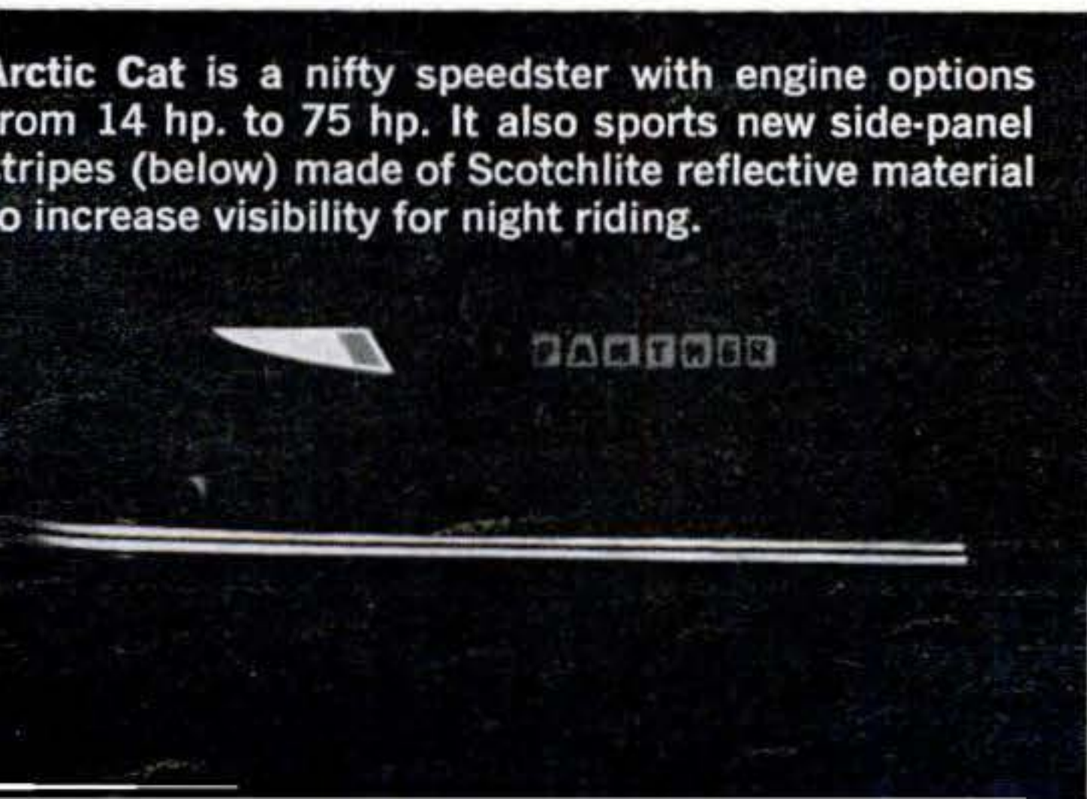
igh on comfort and high on looks. The sleek SnoCoupe is really an en-osed snowmobile with a smart fiber-lass body and a sliding, removable anopy.

It boasts an optional heater for even greater comfort. You can get it with either a 372cc JLO or a 488cc Polaris engine. Prices for the SnoCoupe range from about $2,500 to nearly $3,000.

Another enclosed snowmobile, the Ridge Runner, has no skis. It's a two-

[Continued on page 214]

rctic Cat is a nifty speedster with engine options rom 14 hp. to 75 hp. It also sports new side-panel tripes (below) made of Scotchlite reflective material o increase visibility for night riding.



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What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMEN

Sitting slalom →

Sit down the next time you go skiing. The Ski Sled's pivotal action (provided by ball joints and hinges) lets you control direction by shifting your weight. Pulling back on the handles brakes the contraption. Ski Sled Corp., 6515 W. Grand Ave., Chicago 60635, prices it at $70.

← Foam boat

Buy a boat at a gas station? You can, in Britain. The 9½-foot Pioneer sells for $87 as a rowboat, $140 complete with sails, mast, all gear. Photo at left, with boat cut in half, shows its buoyancy—two-inch-thick polystyrene walls can keep it afloat with five adults, even when flooded.

Half in, half

Now there's a semi-hover
The 10-hp. engine of t
perimental Swedish one-
drives both air prop a
fan, moves it at 21
Three "keels" and a tri
(adjustable to control
height) contain the air cu
Advantage over regular
craft: chea

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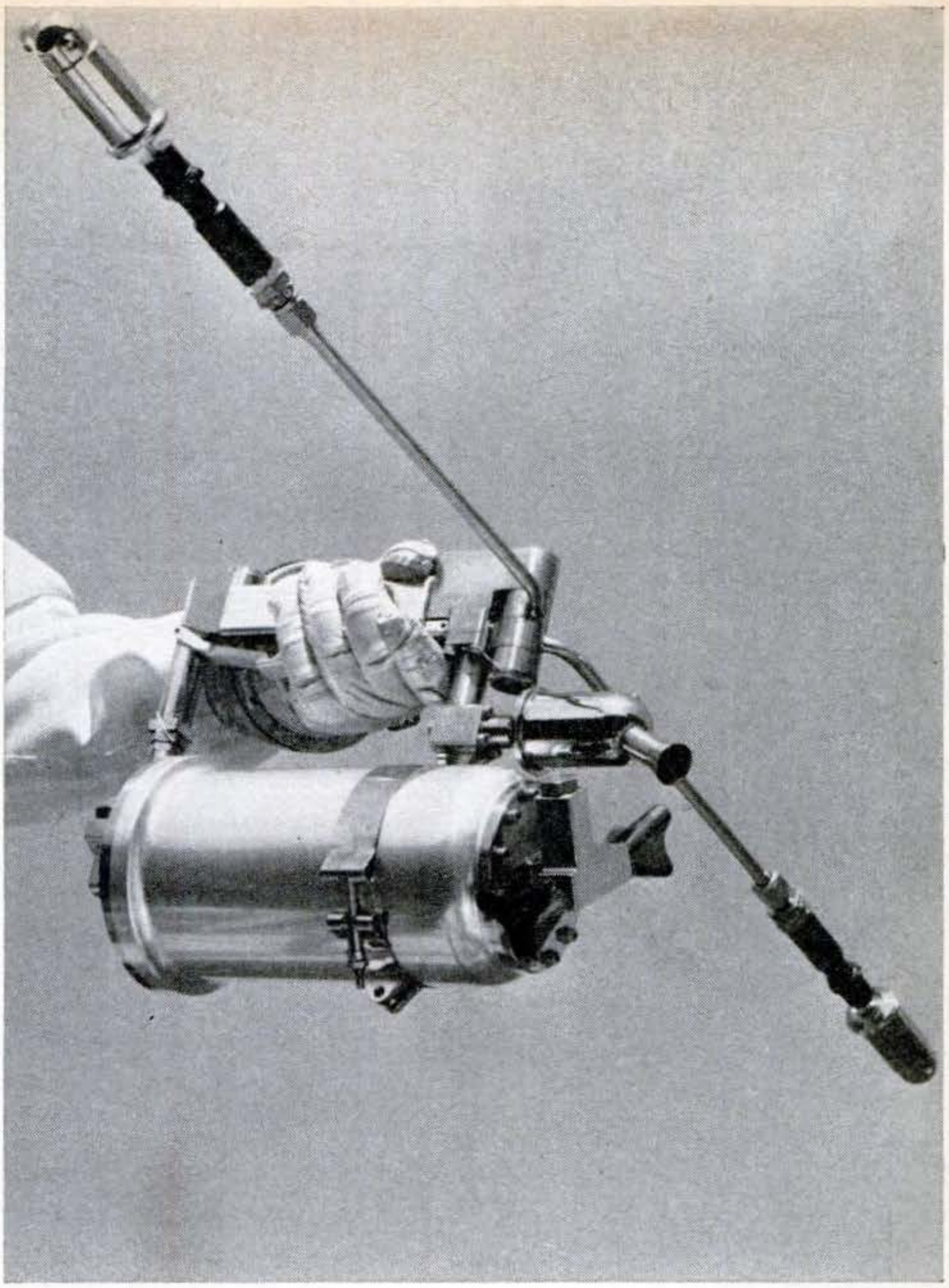
HHHMU →

Here's the unit 1970 astronauts will use to maneuver in space. Self-contained, Rocket Research Corp.'s HHHMU (Hydrazine Hand-Held Maneuvering Unit) has three tiny rocket motors that enable an astronaut to control his movements outside the spacecraft. Fuel tank attaches to handle.

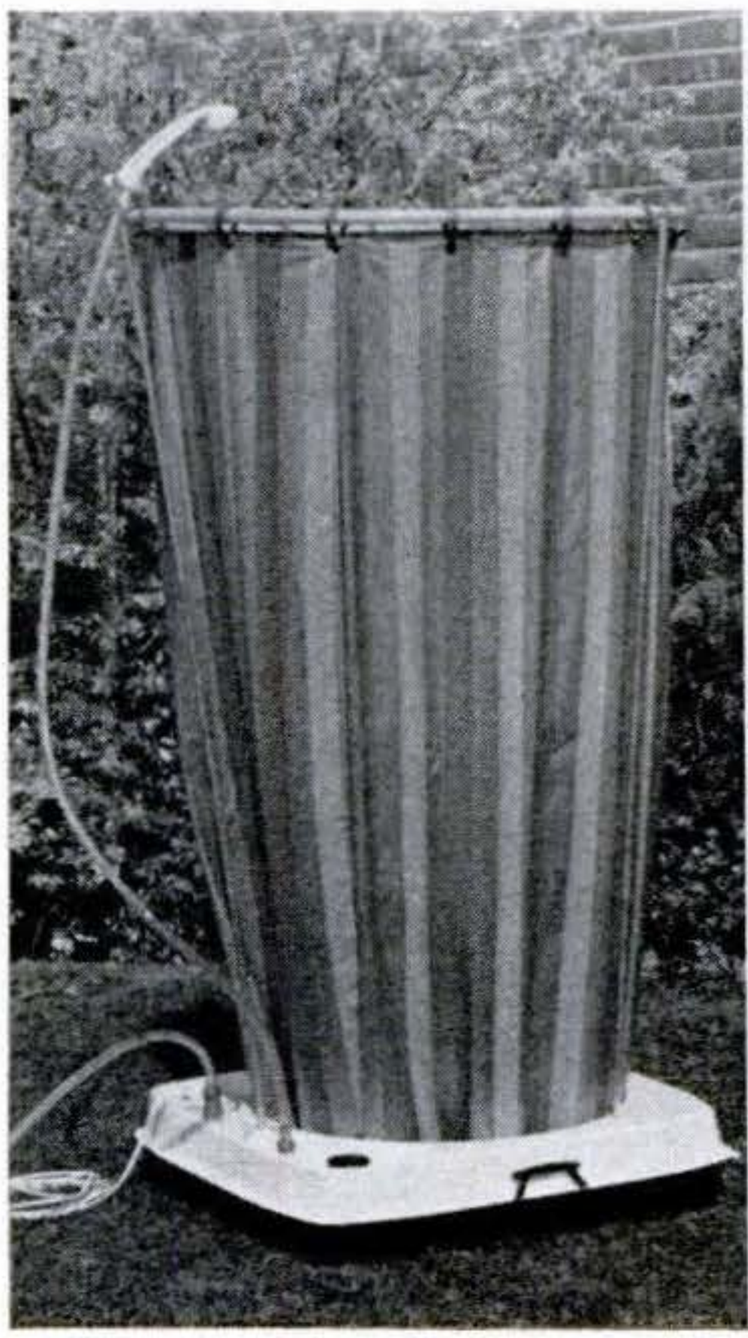


Tube saver ↑

Sapphire windows at $2,500 apiece increase the life of projection TV tubes used by the military. The Raytheon faceplate, for radar and computer-controlled displays, conducts heat away fast to prevent burnout. The disk, man-made, is one of the largest single-crystal sapphires in existence.

Shower in a suitcase →

You're ready for a shower any time with the Anywhere Shower. Carry it along with you. It weighs 10 pounds, gets its pumping power from house current or a car battery. Five gallons of water give a four-minute shower. It's priced at $150 by Mininome, 11 Yates Ave., Commack, N.Y. 11725.



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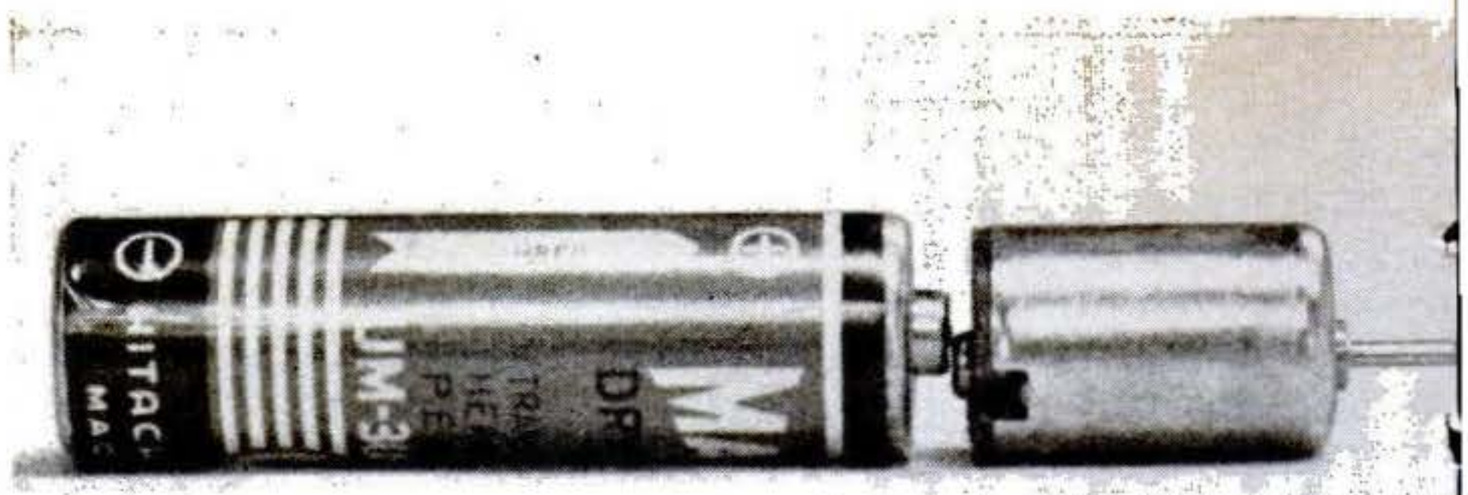
What's New



Peanut power

Place a 1.5-volt battery again the RM-01 DC motor—world smallest, claims Japan Mabuchi Motors—and *whoos* it's spinning. It needs n wiring or switch. The mot is ¾ inch long, ½ inch diameter. Mabuchi sees it fo scale-model planes, game other low-torque application

← Log hauler

Loggers get an all-terrain vehicle in the Nelson Tackler, which rolls on four rubber tracks running over low-pressure tires. Tracks haul the vehicle over boulders, logs, gullies, or railroad tracks at up to 15 m.p.h. An electronic control slows or stops the input shaft for gear changing.

← Finger stitcher

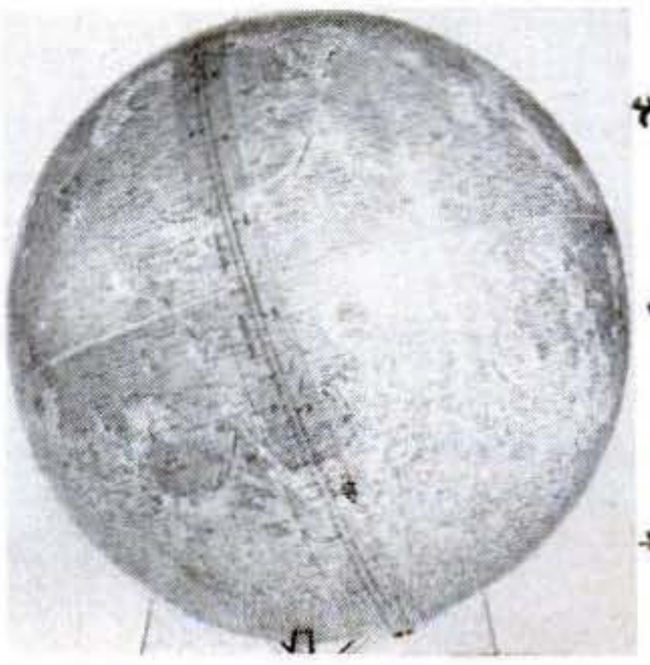
World's smallest sewing machine is the claim for this cigarette-lighter-size Japanese device. Thumb pressure works it—it makes a stitch each time the thumb presses a plunger. A spring returns the plunger for the next stitch. The device sells in Tokyo for 650 yen—about $1.80.

Moon model

Too late for the Apollo astro nauts, but in plenty of tim for Christmas, the map maker have produced an accurat scale-model globe of the moor One inch equals 180 miles o this Rand McNally globe, an 2,300 places and features ar identified. Three 12-inc models sell for $9.95 to $16.9

← Space watcher

Want a close-up of the moon? Edmund's kit offers the optics to ease building your own high-power telescope. Kit includes six-inch, aluminized, parabolic mirror, ⅜-inch-thick elliptical diagonal, and 28mm eyepiece. Price: $75. Edmund Scientific, 380 Edscorp Bldg., Barrington, N.J. 08007.



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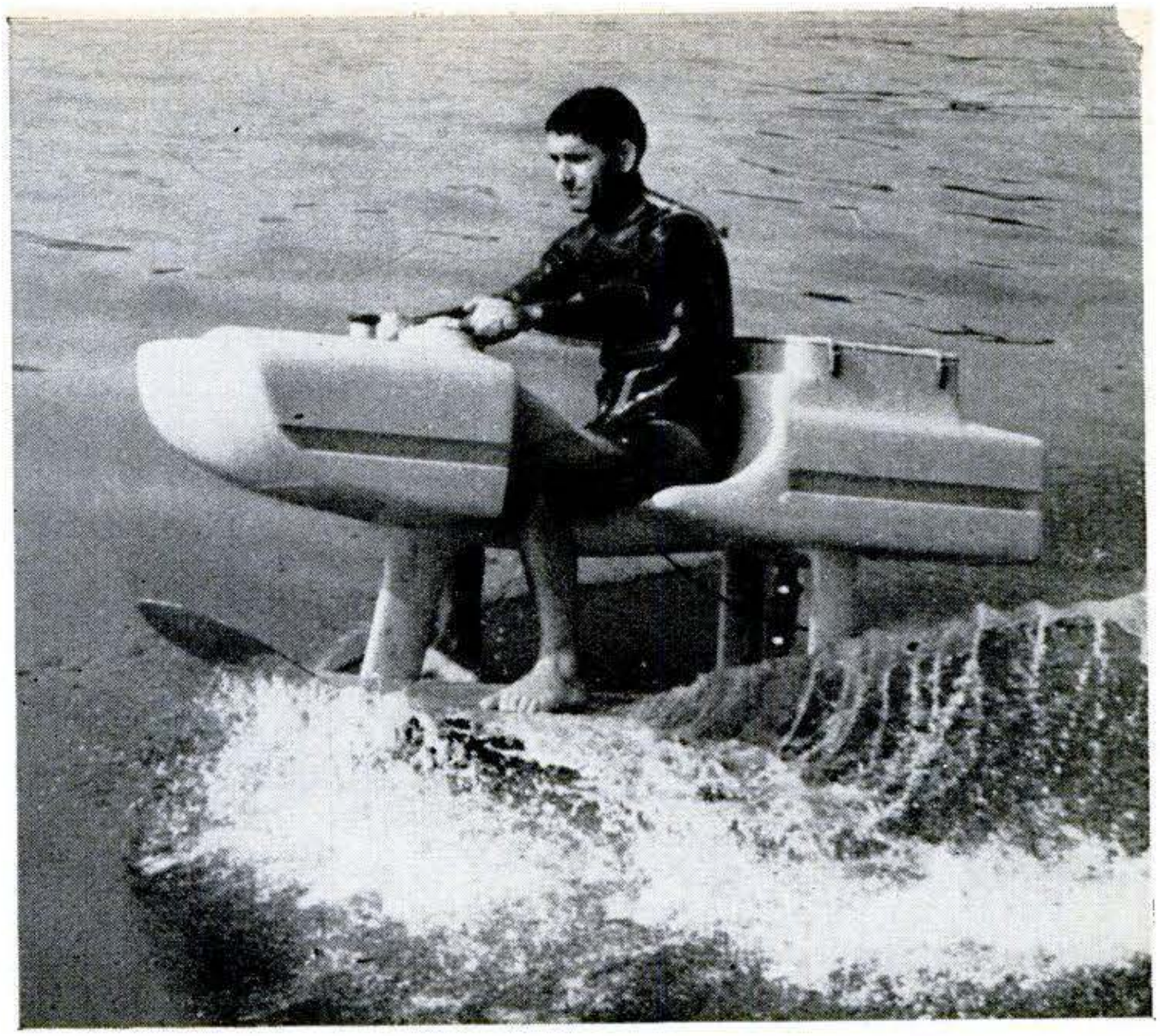
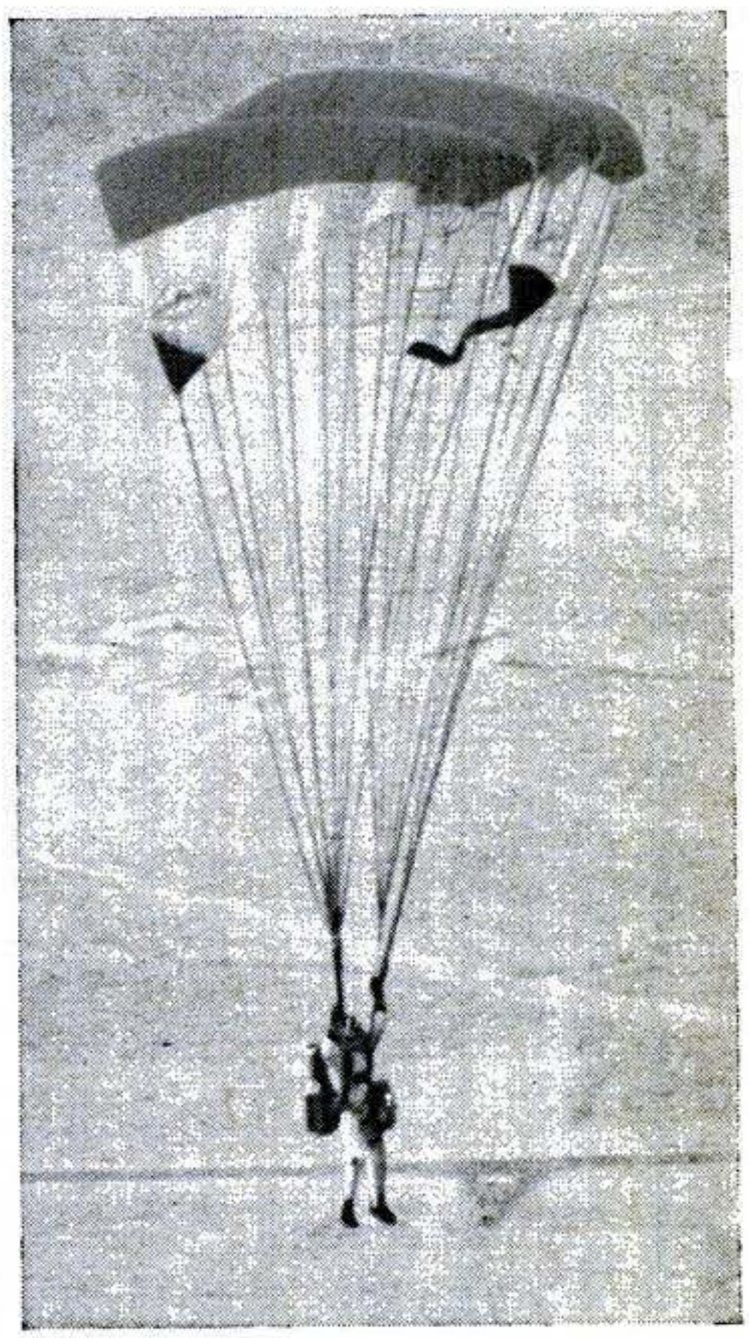
Pink Blitz ➔

Luigi Celani doesn't need a oat to tow him when he goes er-skiing, and he needs only e ski. He's shown at right on Rome's Tiber River, piloting is motorized ski, dubbed the Pink Blitz. It does approxiately 38 m.p.h. Says Celani: "It is very simple but gives unusual pleasure."



Swivel car

trouble parking this threeeel car—it rotates around center point to fit in a ace one inch greater than its e-foot length. The trick: o in-line left-hand wheels t turn in opposite directions. e right-hand wheel is midway ng the chassis. It won a tish Ford contest prize.



Bull's-eye chute ⬆

This Army radio-controlled parawing can be dropped from a plane six miles up and 15 miles away—yet still land within 200 feet of its target. It's steered by "left" and "right" buttons on a ground transmitter, or homes in automatically. Payload for the Goodyear device: 500 pounds.

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What's New

Swim power ➤

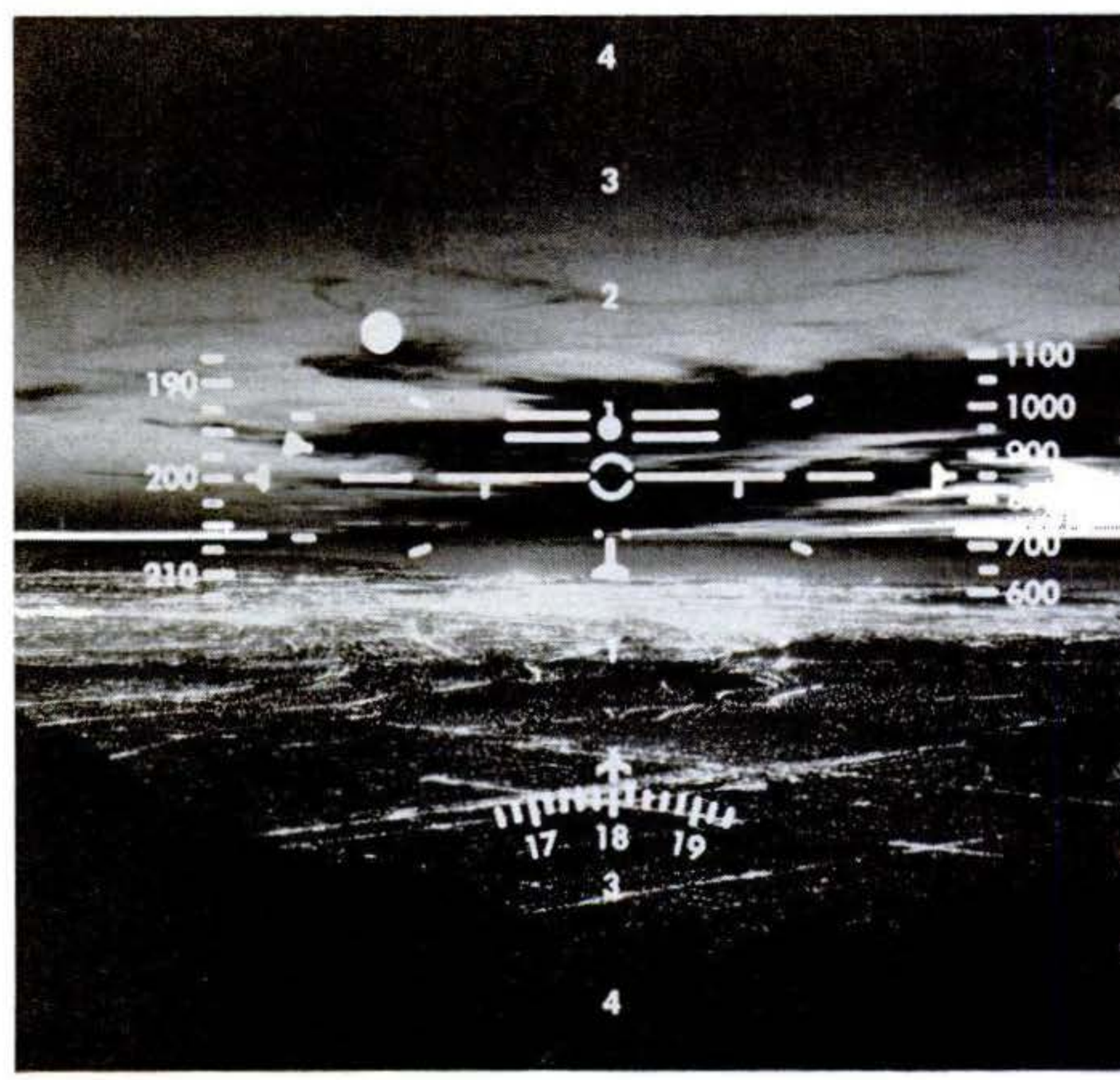
Two quarter-horse electric motors puts *vrooom* in this underwater propulsion unit. It's 42 inches long, weighs 50 pounds, and can do about 5½ m.p.h. Handles under the front fins control the unit. It won an award for Gary Rockwell in an Alcoa design contest. Naturally, it's aluminum.

◄ Fast focus

You're in focus almost immediately with Bushnell's Insta-Focus binoculars. A thumb button replaces the usual slow central focusing wheel. The button slides quickly through a short near-to-far arc, to adjust for sudden range changes. Price for 7x35 wide-angle glass (left): $64.

For pilots: everything on the windshield ➤

A pilot need never take his eyes off the windshield with the Librascope L-193 display. All his most important instrument readings—altitude, compass heading, speed, glide path, etc.—are projected, in bright colors keyed to the information, on an "inner windshield." Light intensity is varied automatically by photocells: brightest, for example, when a pilot is landing into a setting sun, dim at night to minimize distraction. Developed by Singer-General Precision, the system is intended to eliminate the estimated 0.8 second a pilot takes to shift his eyes from a standard instrument panel and refocus on outside objects.



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shing phone

the Code-Com to a tele-
e and a deaf person can
' phone messages in
l flashes of light, or "feel"
in the vibrations of a
' pad. A sensing key on
nit allows a handicapped
n to send light or vibra-
ignals to another Code-
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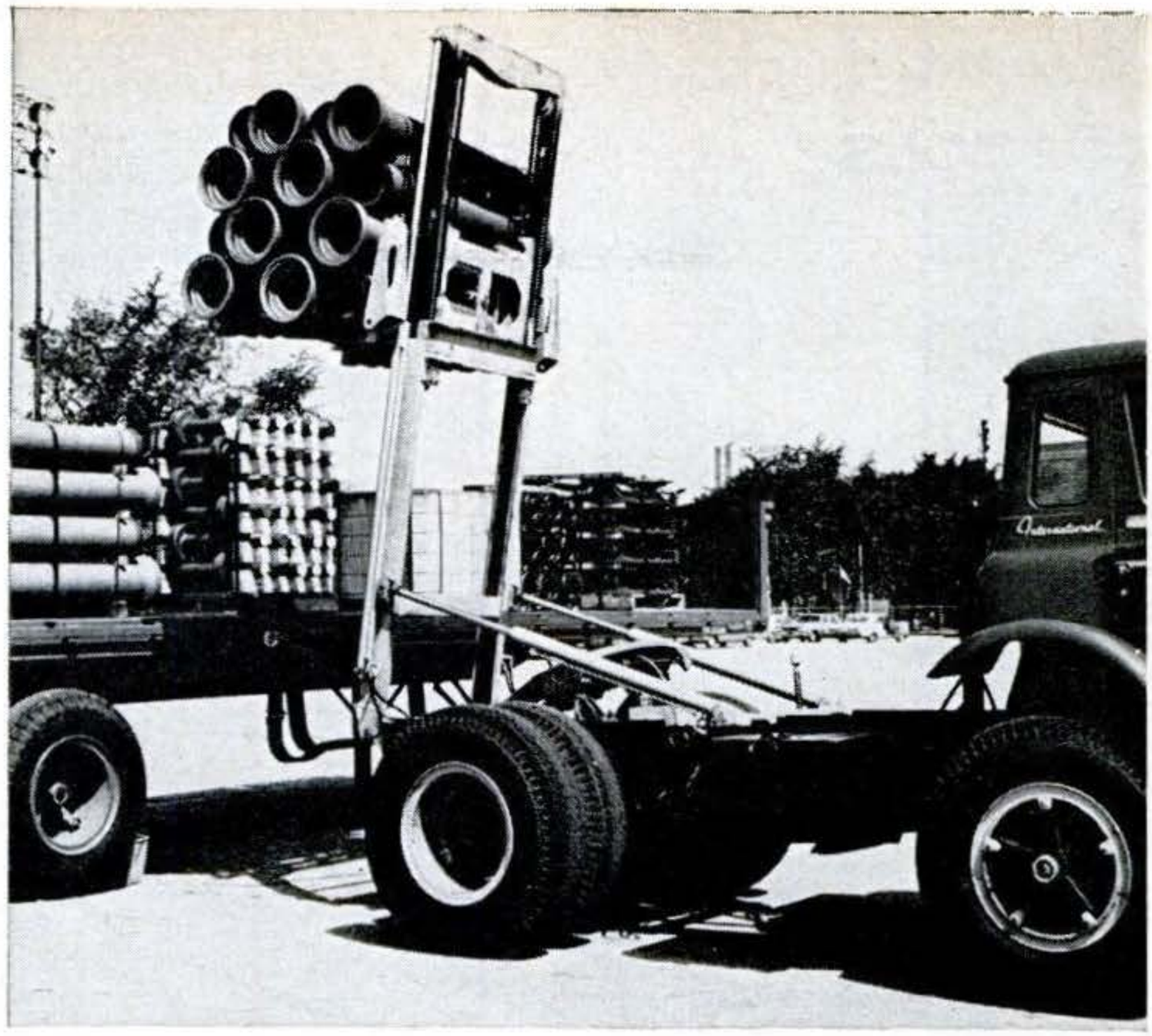

Do-everything truck ▲

This truck is unloading itself. The mechanism is an ASF Foldfork—a compact forklift attached to the tractor frame. The driver never leaves his cab. Arriving at his destination, he moves a few levers, uncouples the trailer, raises the built-in lift mast, and unloads his cargo.

lancing act

a mechanical high-wire
, this trail truck travels on
s the width of its wheels.
et: a 20-inch gyroscope
spins at 5,500 r.p.m. The
vheeler climbs grades up
percent. Summers Gyro
developed it for the
Forestry Service. Coming:
3-foot-long gyro truck.

Magic mixer ►

There are no shafts in this mixer—a magnetic field turns a Teflon-coated mixing bar in the container at speeds of 50 to 3,000 r.p.m. With mixing action below the surface, less air is drawn into the mix. Wein Magnetic Mixer takes containers up to 3½ gallons. It sells for $34.95.

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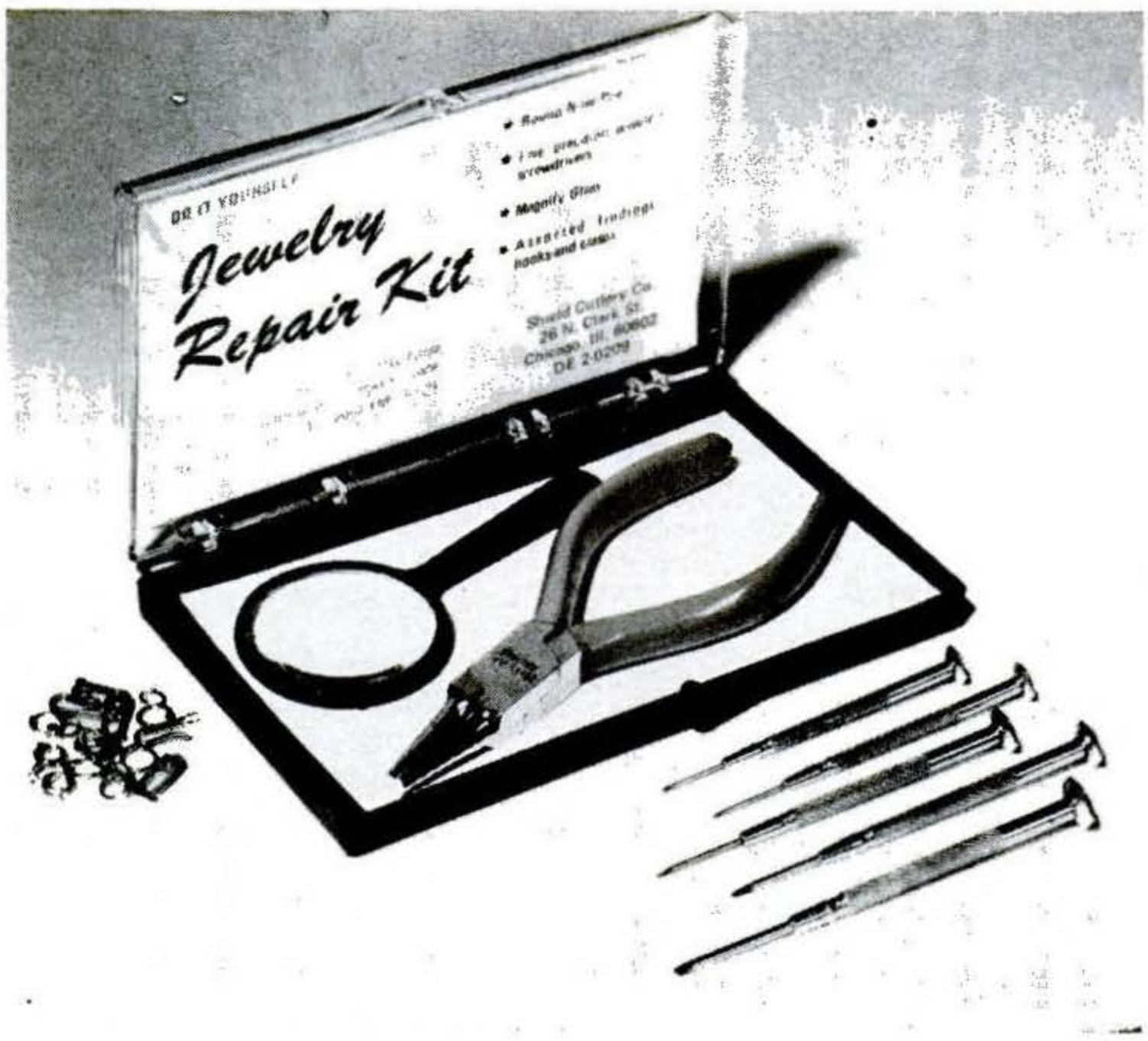
What's New IN TOOLS

Drill dispenser ➤

No sweat finding the drill you want with a Dial-A-Drill. It comes complete with 12 high-speed bits and a center punch. Each piece has its tailored slot. When you dial the plastic cover to the size you want, a hole lets only that size bit slip out. $7.99 from Black & Decker.



➤ Mini repair kit

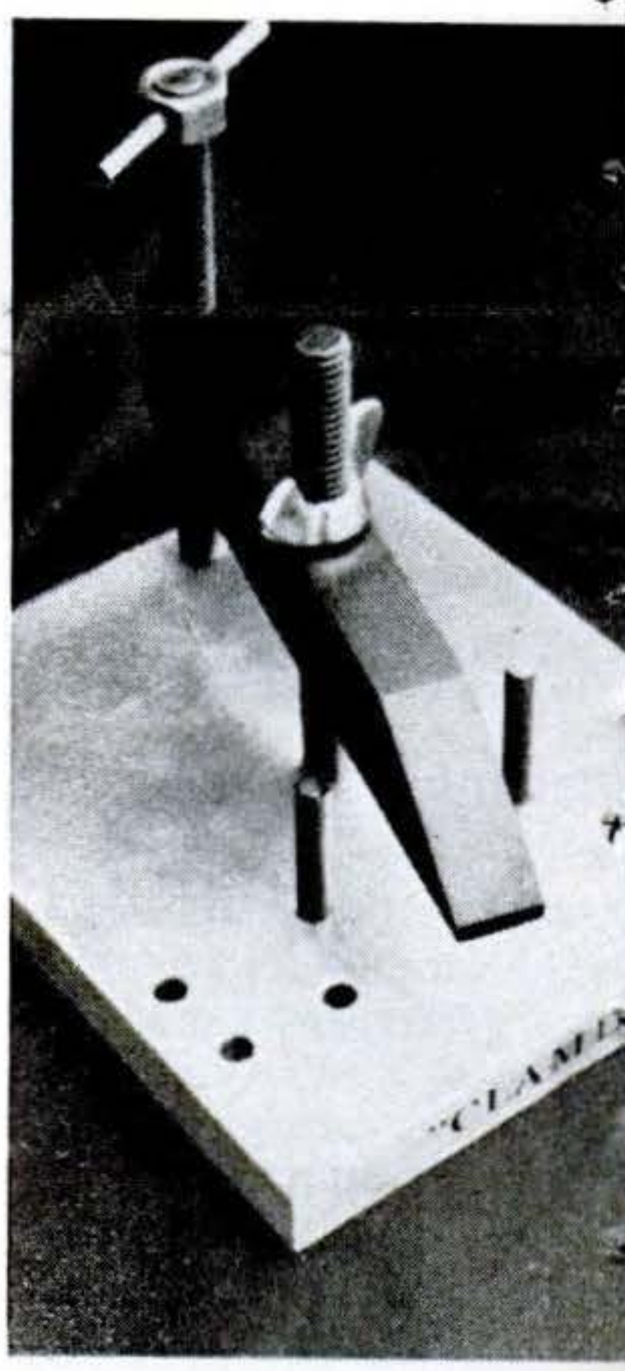
Regular tools are too hefty repairing eyeglasses, cam and bracelets. This set is signed for such jobs: five-i pliers, five screwdrivers of selected sizes, plus magni glass. Jewelry findings inc hooks, clasps, and links. With case, $4.95. Corrado, 33 E. Adams, Chicago 606

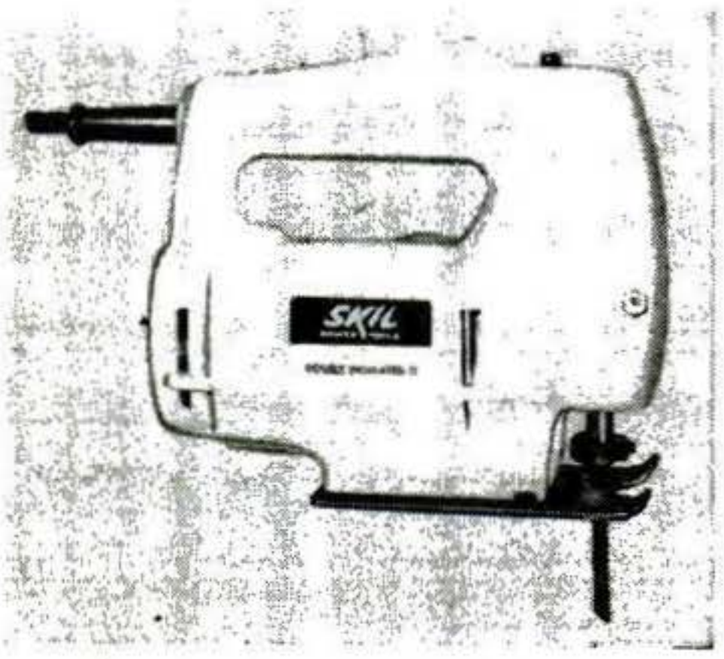
Versatile clamp

With a feather touch forceful grip, this horizo vise with its aluminum plat can put the clamp on anyt for drilling, filing, solde gluing. Other parts are s Standard Clamdown (fou five base, 2¼-inch jaw is $8.48 from Ditto, 52 Alexandria, Los Angeles 90

➤ See-through slicer

Two tools in one is this shatterproof disk. Used edgewise in an electric drill, as here, it's a cutting wheel that zips through stone, tile. Sideways, it's a sanding disk for shaping, sharpening, or removing rust and paint. Whizz-Disc is $3.50. Arco, 421 W. 203 St., N.Y. N.Y.





➤ Shockproof

Newest entry in the double-insulated parade is Skil's 482, which weighs only 3¼ pounds, retails for $29. It needs no ground plug. Your cutting line is kept clear for its ⅝-inch stroke by a built-in blower. All Skil accessories fit; rip fence and circle cutter can be used on either side of tool.

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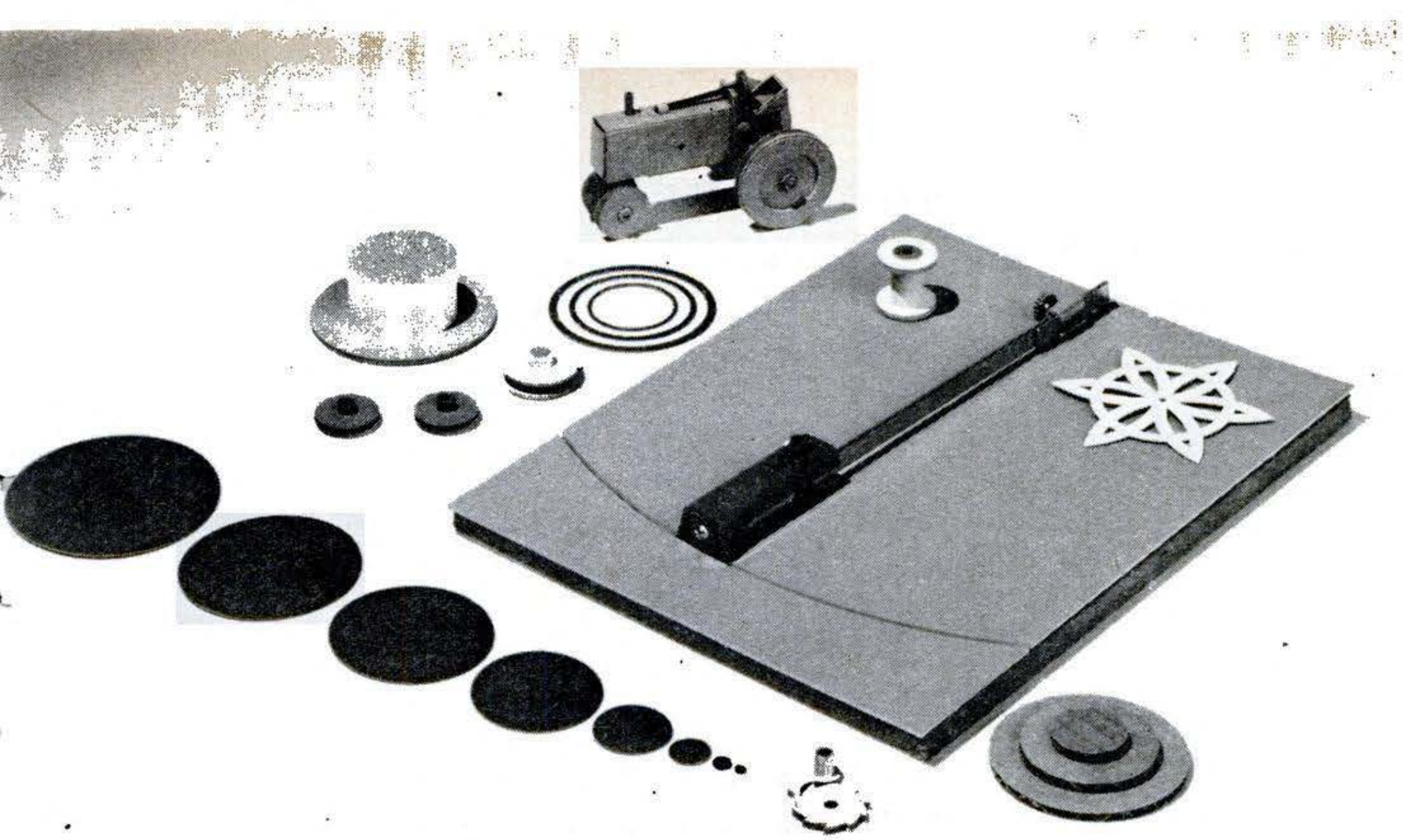


Circle cutter ▲

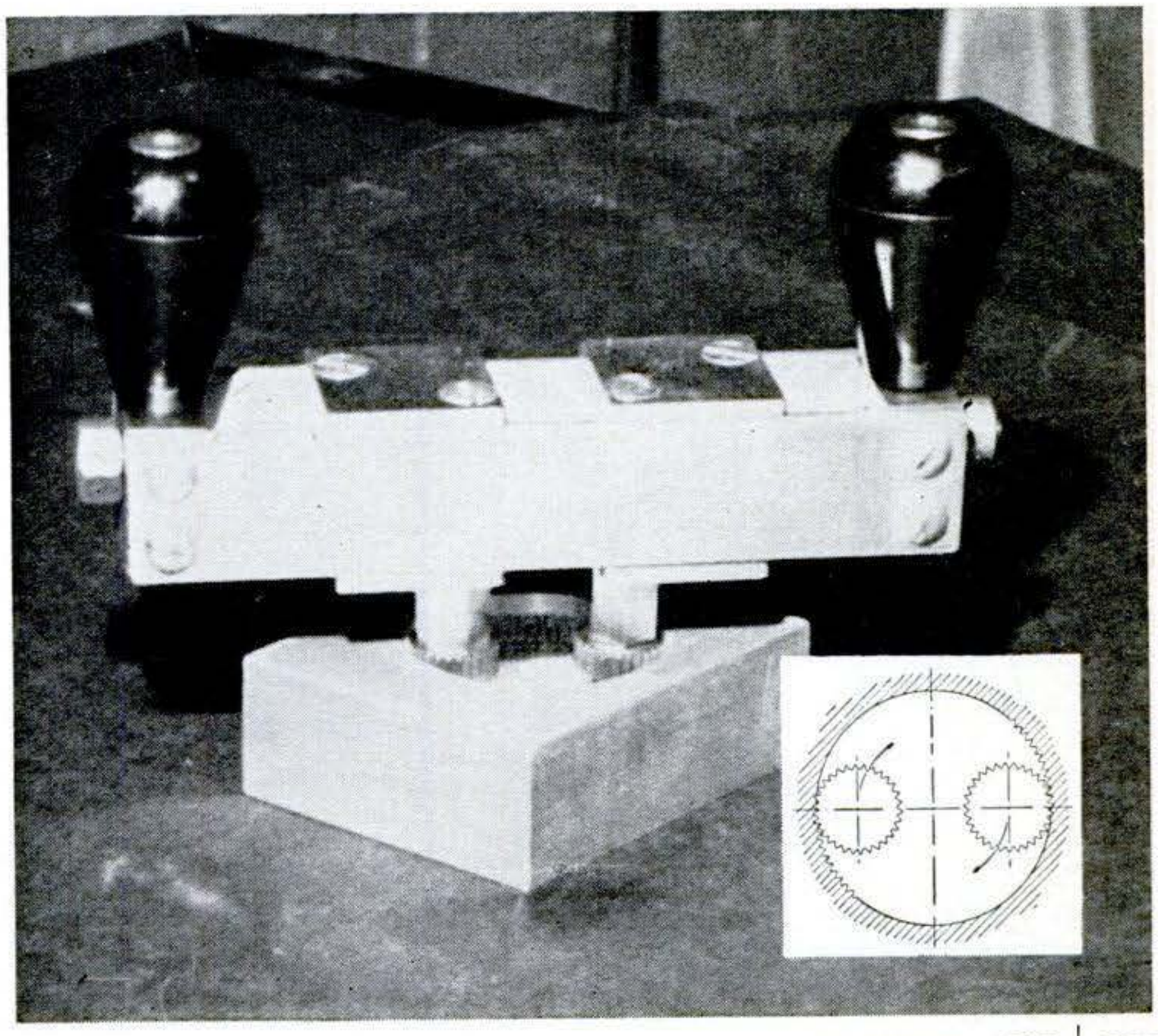
You'll be swimming in disks of all sizes when you try the Accu-Orb circle cutter. Quick adjustments of a reversible pivot bar let you cut diameters from 1/8 to 24 inches in cardboard, gasket sheet, rubber. With 10 blades, it's $7.95. Technological Devices, 39 Echo Hill, Stamford, Conn. 06905.

◄ I say! a Black Prince

olly good name for this new aw from England, what? Created by a silversmith who lesigns for the Queen, it eatures an immovable olypropylene handle that's nolded to the Teflon-S coated lade. Four sizes, $8.25 to $8.95 from Spear & Jackson, 30 Church St., N.Y., N.Y.

Hole-shrinker ►

Holes bored, punched, or worn too large? You needn't press in a bushing if you own this hand tool designed to add material to the inside walls. Two knurling heads rotate within hole (sketch) and are adjustable to many diameters. $33.50. Knurlmaster, Rt. 3, Freeport, Ill. 61032.



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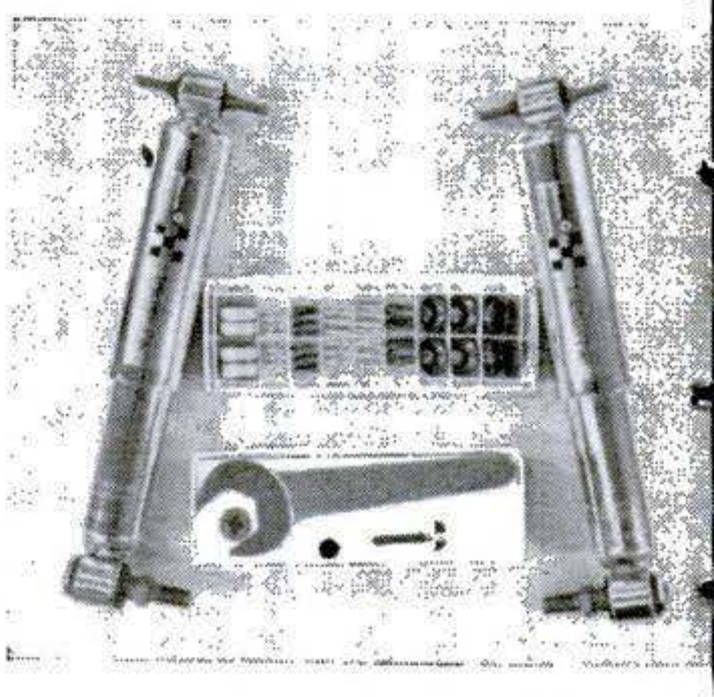
What's New
FOR YOUR CAR

Hotter ignition →

Here's the latest word around the speed shops: high-performance ignition kits by Echlin. Whether you want more power for track, strip, or street use, Echlin has a kit (for most U.S. cars). An eight-page brochure is available from Echlin, Box 472, Branford, Conn. 06405.

Ride control

These shock absorbers can be taken apart and rebuilt with different calibration to give different shock-damping characteristics. Traction-Pac kit includes an assortment of valves and springs enabling you to change ratios between 9:1 and 1:9. It's sold by GM-Delco dealers.



← Bright moldings

Reflective red car-door moldings give a high-visibility warning when you open a door, and add protection against chipping the door edge in tight parking spots. The moldings are made of Tenite butyrate by Silvatrim, 863 65th Street, Brooklyn, N.Y. 11220.

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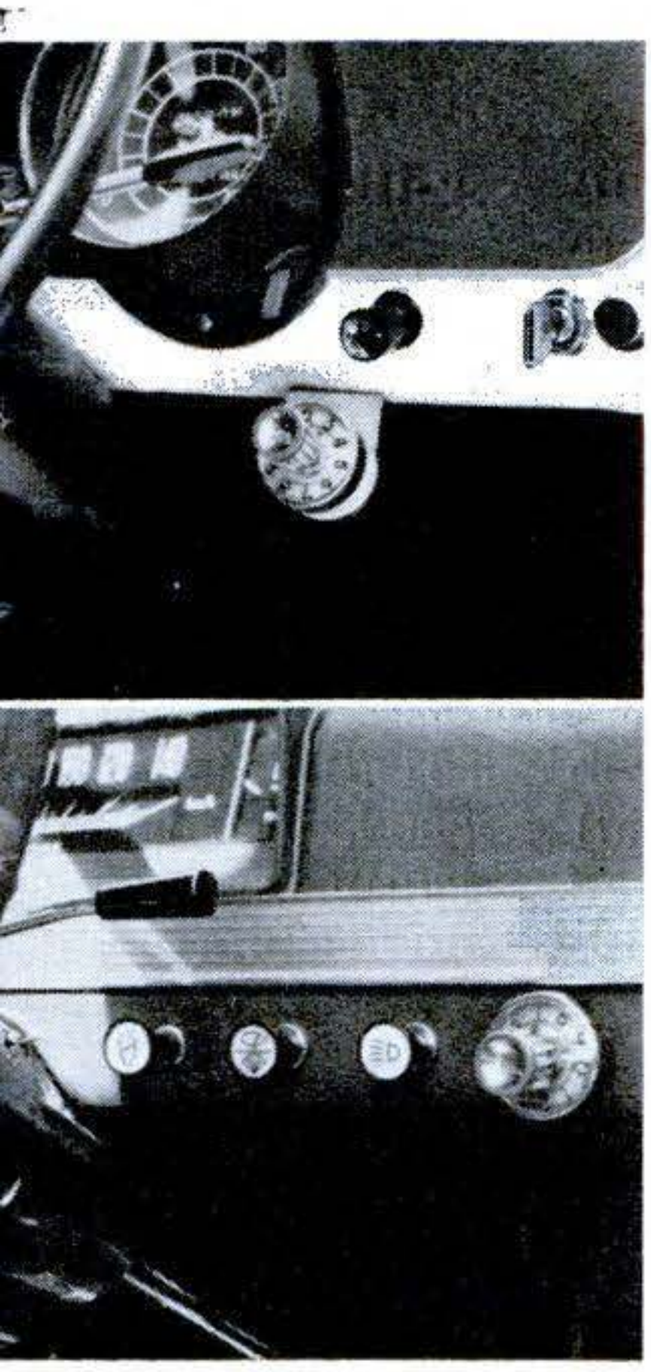
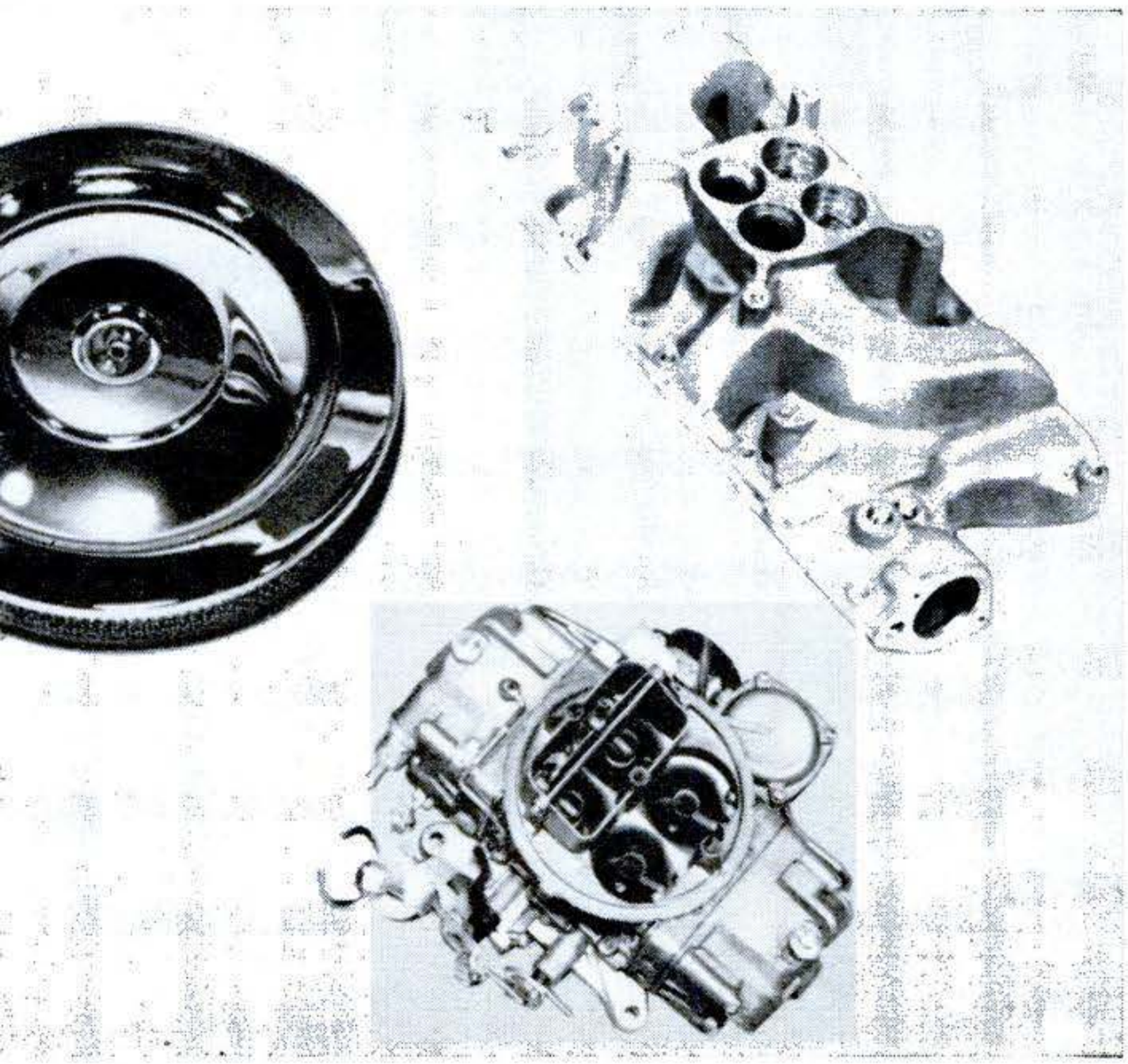
Electronic anti-theft

al your ignition? Sure, with e Securo-Guard. It converts ur ignition lock into a com- nation lock. It can be used ong with the regular key rst photo, below) or can be stalled in place of the original ck (lower photo). $19.95 om Securo-Guard, 675 E. 77 , Brooklyn, N.Y. 11236.





↑ All in one place

Everything has a place in the Auto Mate—road maps, sunglasses, memo paper, pen, cards, receipts. It also includes a first-aid kit, flashlight, fire extinguisher, and a set of screwdrivers. It fits over the transmission tunnel. $7.19 from Jennie Jones, Box 73, Blackridge, Va. 23916.

← Soup-up for Fords

Ford dealers will soon offer performance options for the aftermarket. Here's the kit for the small V-8 family. The Holley four-barrel carb, high-riser aluminum manifold, and low-restriction air cleaner give you 31 to 34 extra horses. A new camshaft adds 81 more hp. Top boost: 155 hp.

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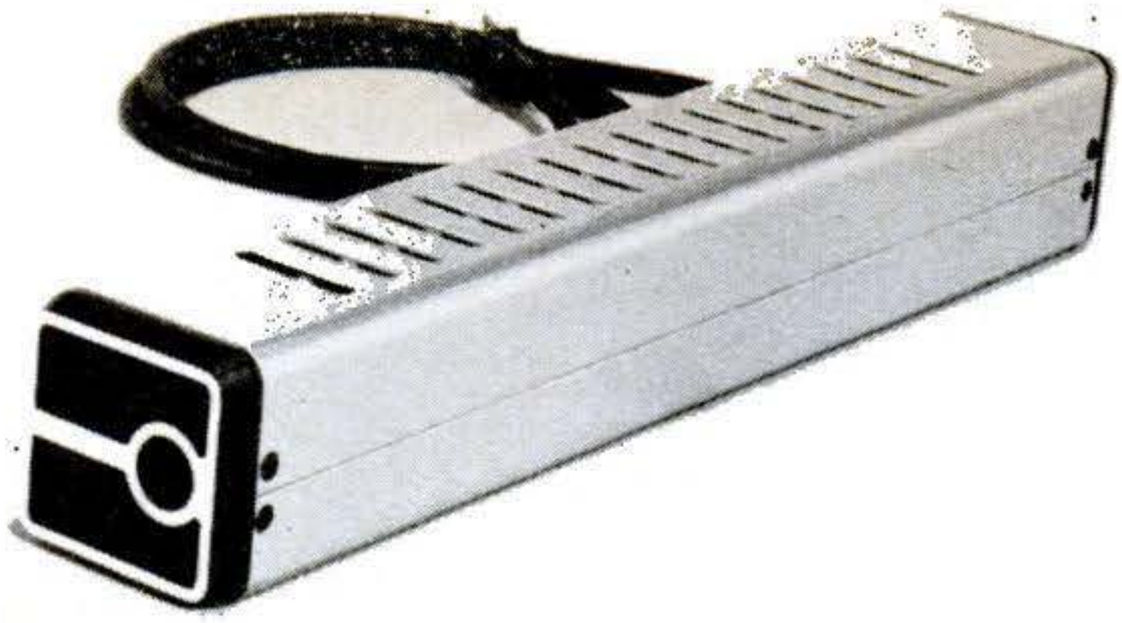
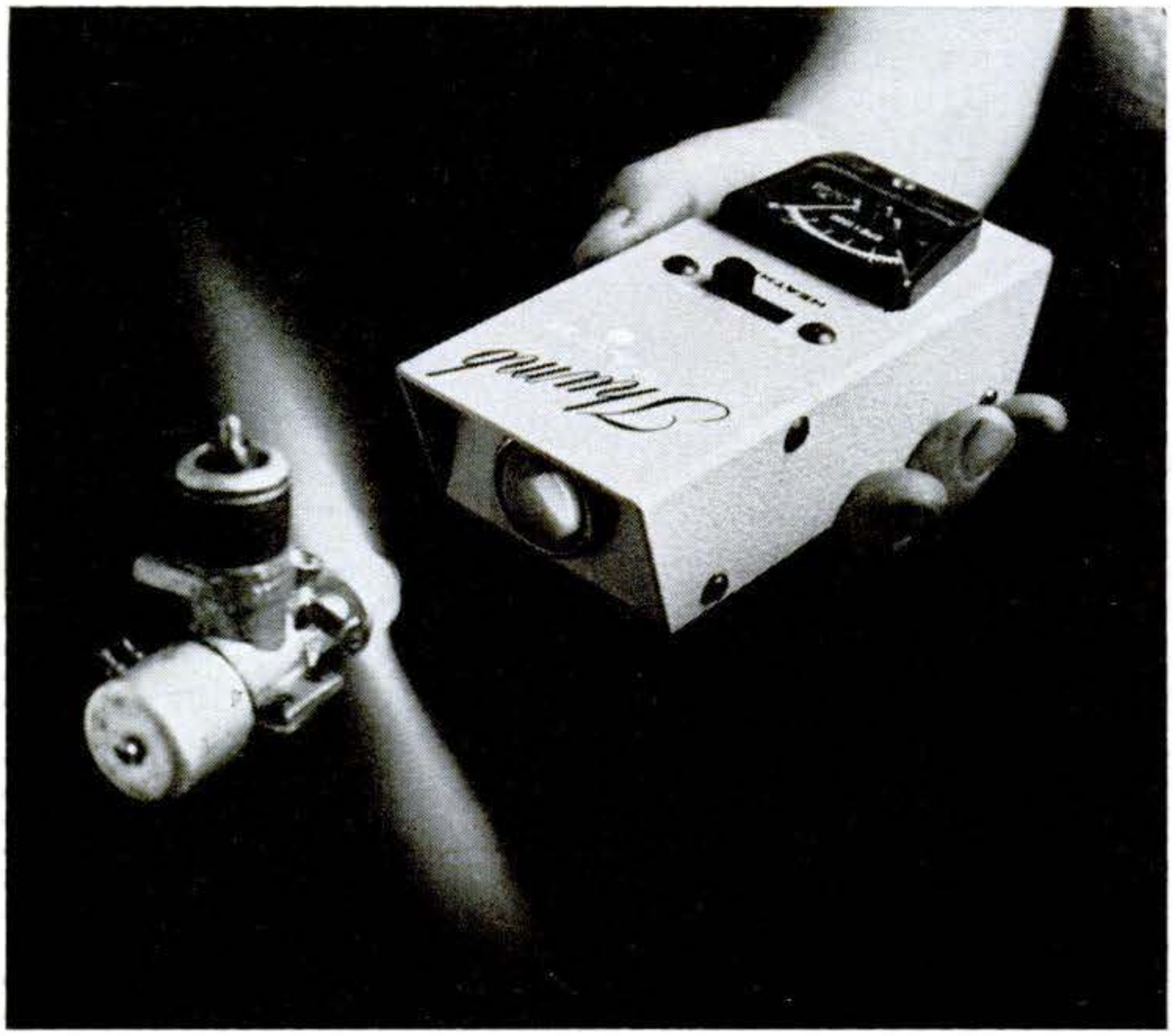
What's New
IN ELECTRONICS





Little gas laser

The bright red light beam fr this helium-neon laser shi several miles with the help an ordinary telescope. And creates pretty effects on glass, gems, or floating smo Quantum Physics, 1295 For wood Ave., Sunnyvale, Ca 94086, sells it for $170 a kit, $225 assembl

▲ Electronic counter

Tuning a model engine? Thumb Tach helps by indicating r.p.m. on a 0-5,000 or 0-25,000 scale. It counts light reflections from the spinning prop. To time a shaft or flywheel you can stick on two tape strips 180 degrees apart. The GD-69 is $19.95 from Heathkit, Benton Harbor, Mich. 49022.

Needle-nose probe ➤

This new high-voltage probe can nose around in electronic circuits carrying up to 30 kilovolts and indicate its findings on a built-in voltmeter. The Eico HVP-5 was designed for quicker, more convenient voltage measuring by TV servicemen, technicians, and engineers. It sells for $19.95.

◄ Sophisticated rig

You can use 115 or 12 volts with the Messenger 124, E. F. Johnson's newest 23-channe citizens band radio. A crystal filter provides high selectivity fine tuning pulls in off-frequency stations. The transmitter uses speech com pression. Meters monitor modulation. $289.95.

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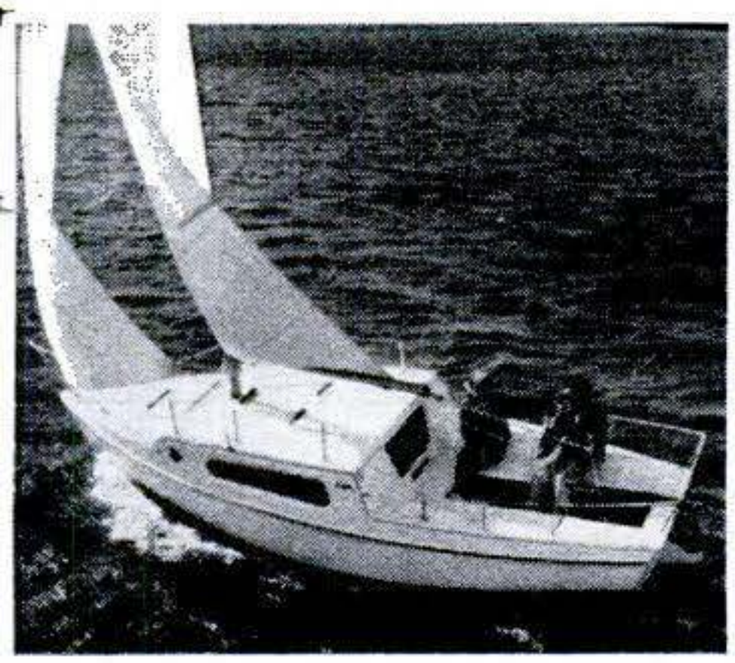
What's New
IN BOATING

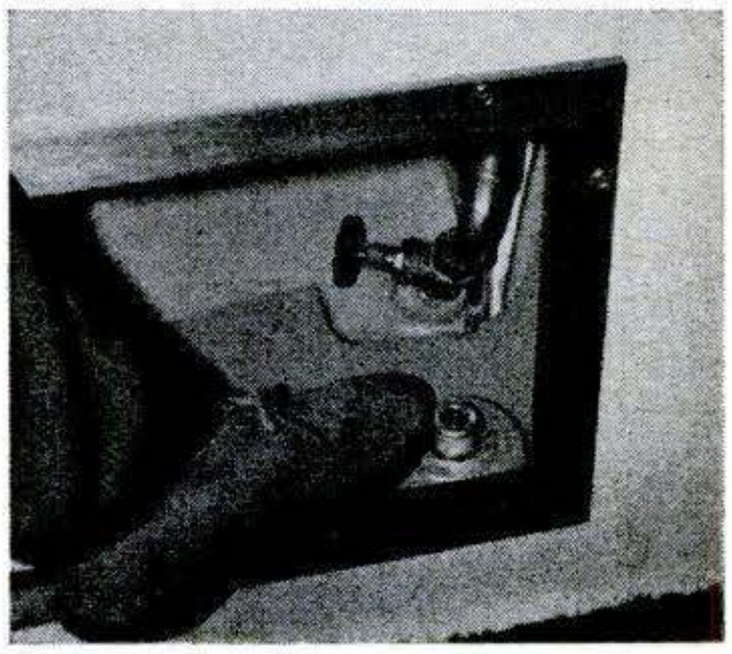


↑ Four-sleeper sloop

It doesn't take skill—just small tools, $2,000, and your own time to assemble fiberglass parts into this 20-foot centerboard or keel boat. The kit includes sails, rigging, cabin interior, hardware, and trim. From Luger Boat Kits, 9200 Interstate 35 W. South, Minneapolis, Minn. 55431.

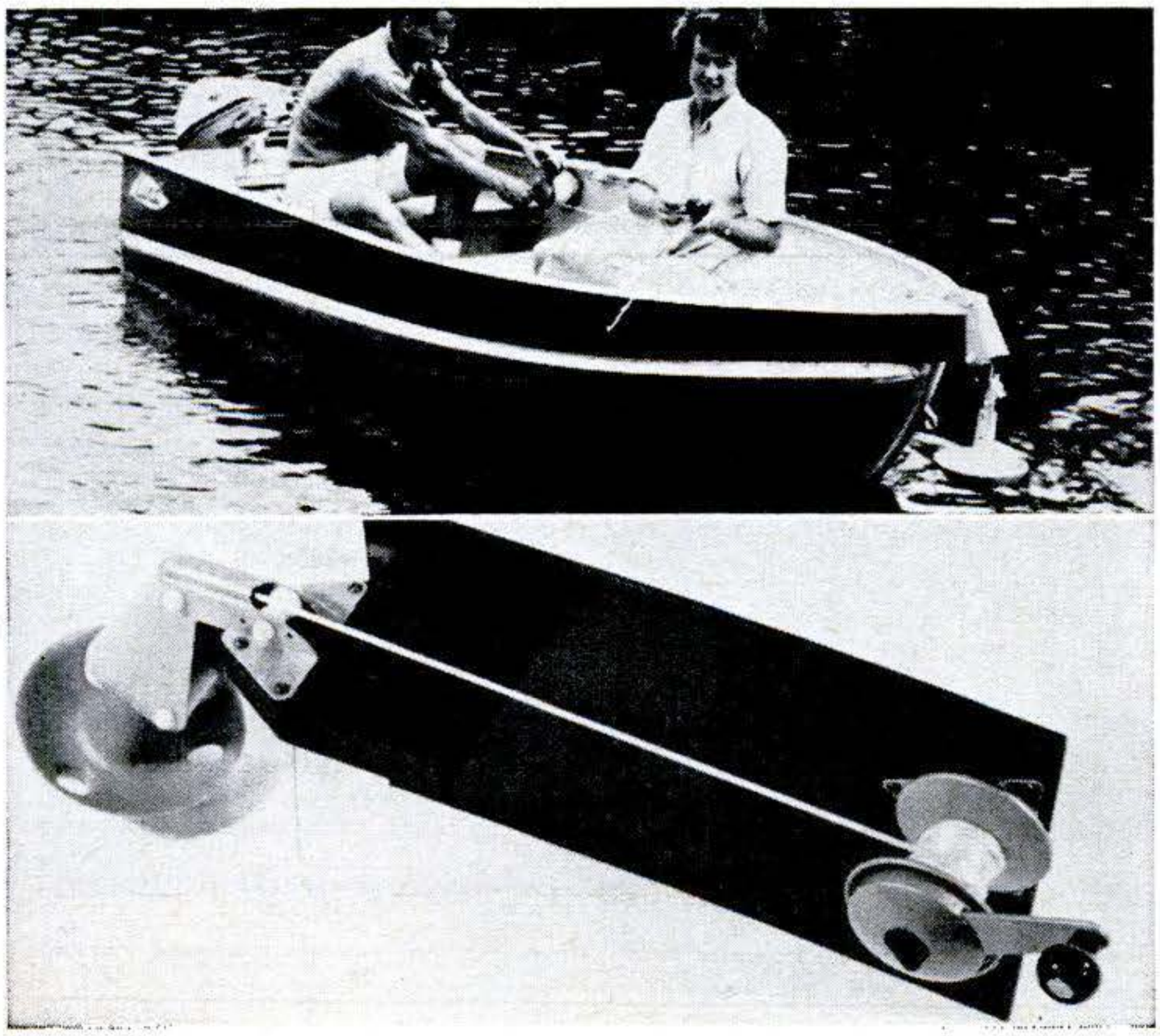
Family dinghy ↑

You can sail, row, or power this 14-foot British fiberglass dinghy. It holds five, weighs only 160 pounds, has a centerboard storage well, bow rail, and built-in air tanks. Mast and sails are included in the $795 price set by Richmond Marine Ltd., 226 Sheen Lane, London S.W. 14, England. It'll soon be sold in the U.S.



Galley slave ↑

Want water? Step on the plunger. It sends water squirting out of a galley faucet above, leaving your hands free. Under the plunger is a two-gallon-per-minute, smooth-action pump that's self-priming and sells for $21 at marine suppliers. Whale Pumps of Venice, Calif., makes the Tip-Toe.



← Anchor release

Here's the lazy-man's way to anchor: Just turn Anchormate's button to drop the hook. Want to heave it up? Turn a crank—no need to stand up or move around. Reel fits in a three-point bracket mounted on the hull. The Worth Co., Stevens Point, Wis. 54481, sells reel and mount for $21.50.

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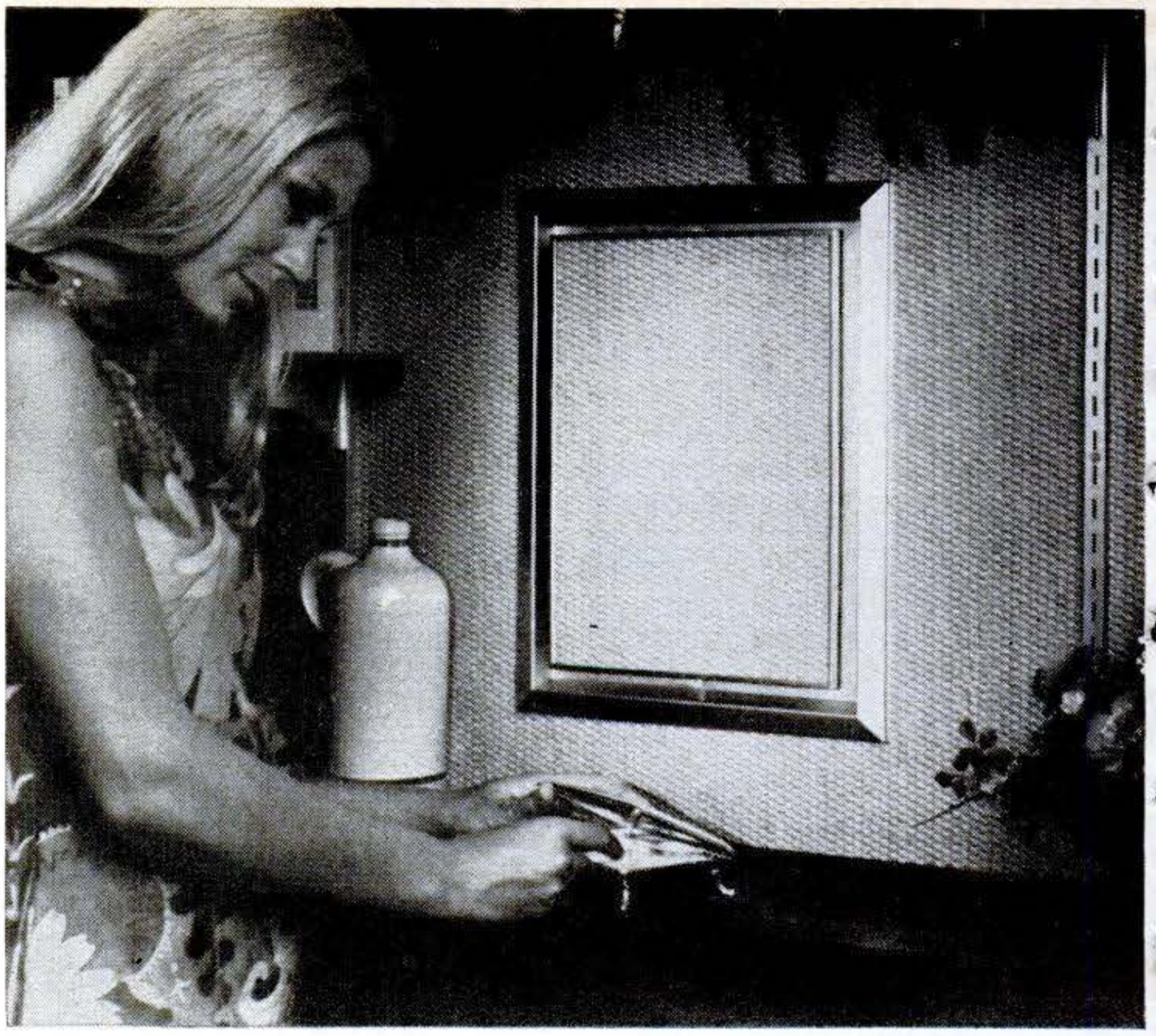
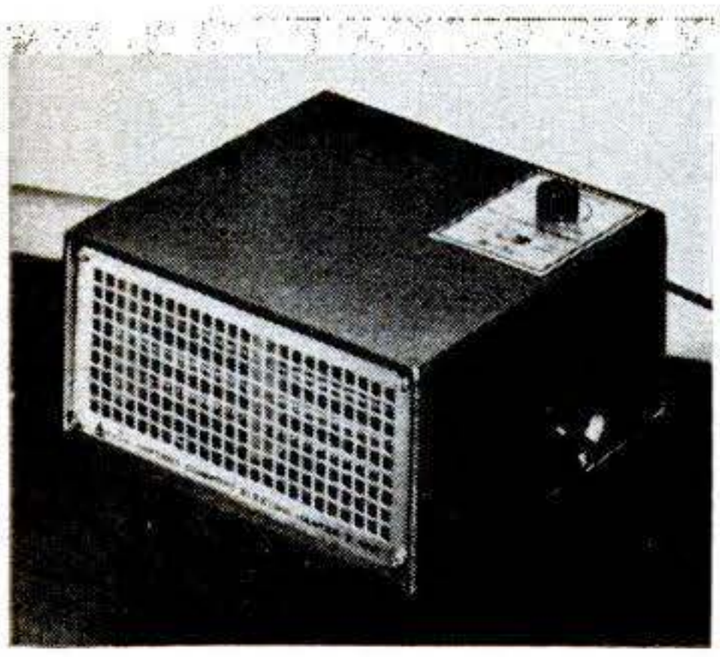
What's New
IN HOME IMPROVEMENT



No-show fan ➤

You get both fresh air and clean lines with NuTone's new flush-mounted wall fan. Air moves through concealed ports in the aluminum frame, allowing the center panel to be finished to match your wall. The unit telescopes to fit in exterior walls from five to 10 inches thick.

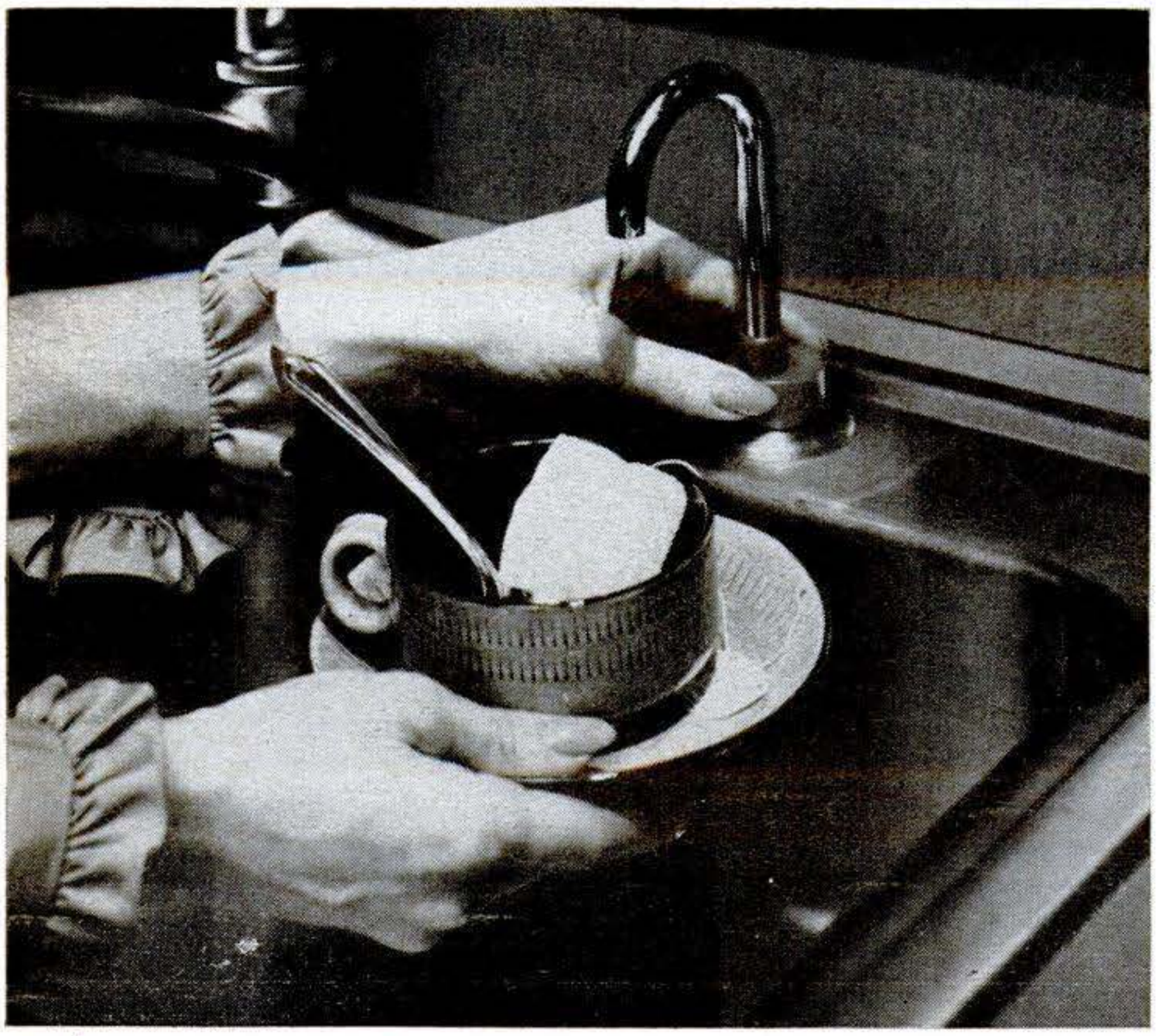


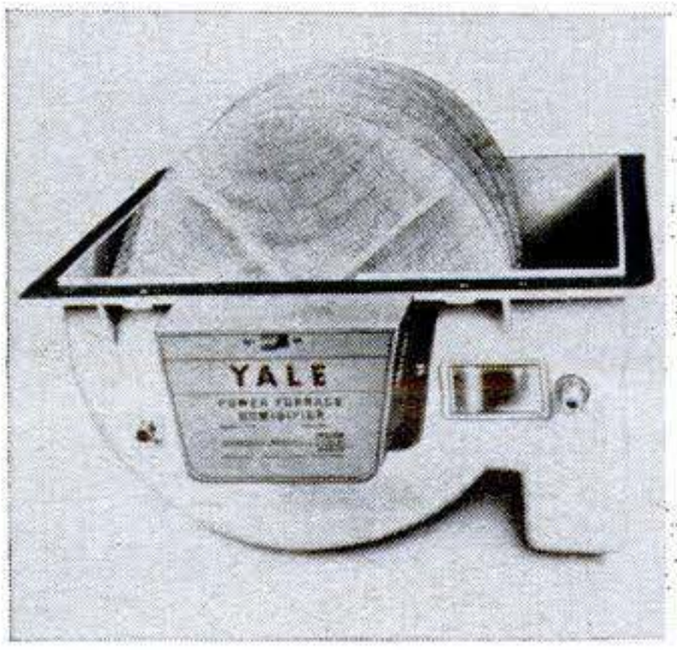
➤ Fan for all seasons

Blowing hot and cold is the specialty of Arvin's Heat 'R Cool. In the winter, it's an electric heater with fan-forced circulation. In summer, you push a slide switch and it's a fan, moving 36 cubic feet of air a minute. It's about as big as a telephone, weighs four pounds, sells for $17.95.

Unsparker ➤

Sparks fly when you kiss your wife? You need moisture in your house. This Yale furnace humidifier can be installed, says the maker, in the underside of any hot-air duct. Twenty rotating bronze disks pick up "sheets" of water from the reservoir and feed them into your heating system.





➤ Hotter water

Water hot enough for tea or instant coffee—205 degrees—flows from the Redyhot at the push of a button. Secret: a half-gallon tank under the sink, heated by an immersion heater. Installation involves a cold-water line and 115-volt power connection. Operation costs about 50 cents a month.

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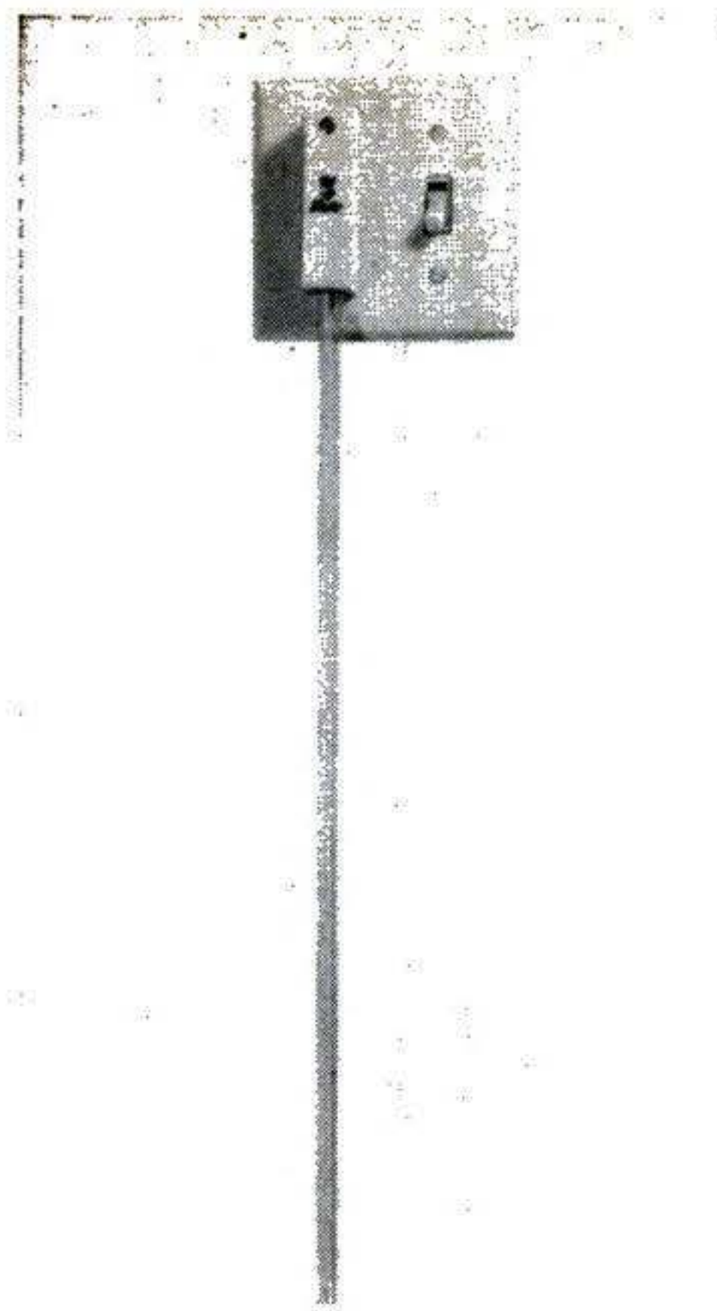
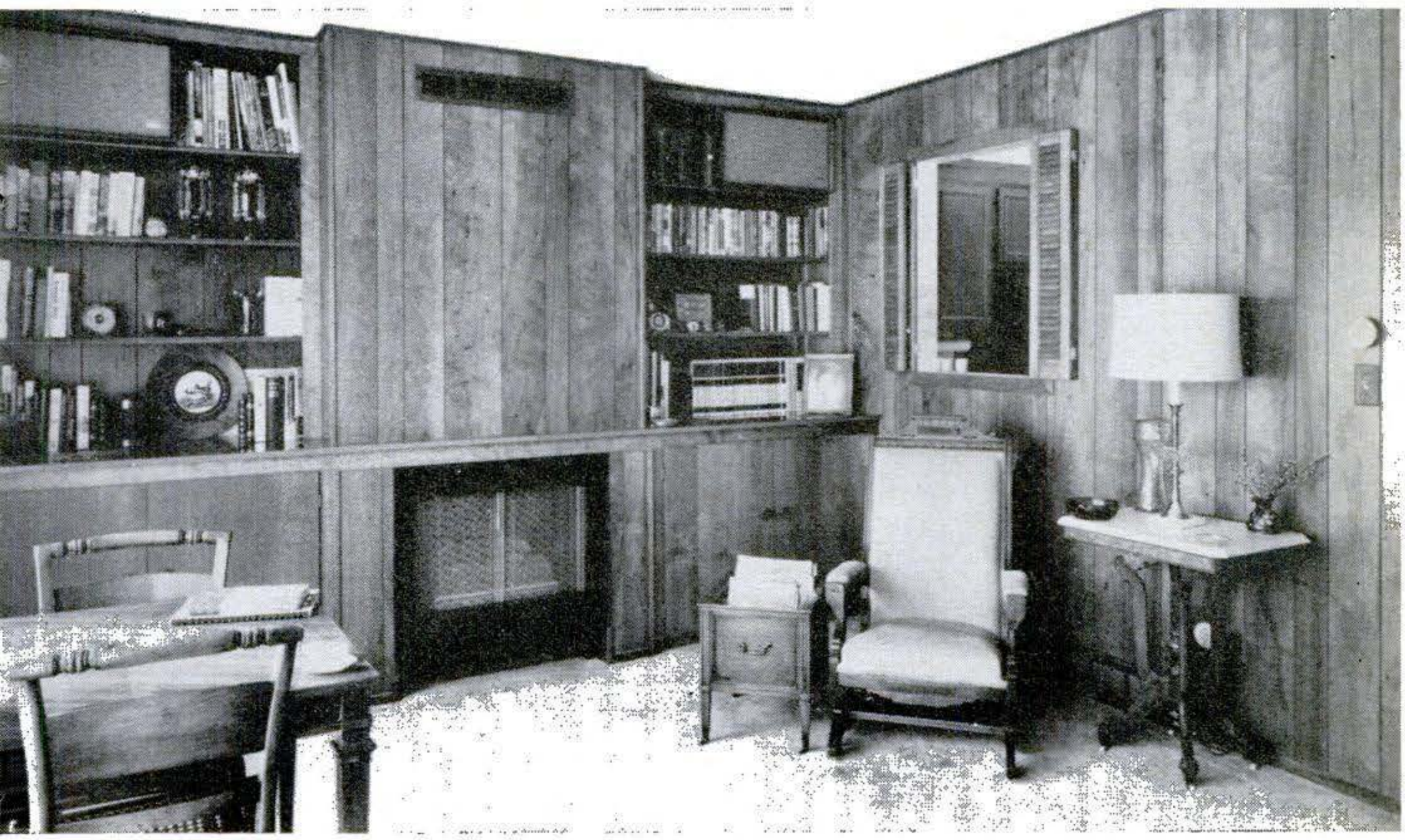
◄ Gas light

Blackout? Here's emergency illumination—the new Buddy-Lite. Attach it to one of Ronson's four larger butane injector tanks and you get 50 hours of light, says the maker. Flame is adjustable up to almost three inches. With a 250-gram Multi-Fill injector, it sells for $3.95.



Kid stuff ►

Take a rest, Dad; now you don't have to follow Junior around to turn a light on or off. He can do it himself with the Tot-O-Matic switch extension. Cover and rod fit over existing switch and plate, install in seconds. It's $1.50 from A-J Assoc., Box 19005, 9135 Katy Freeway, Houston 77024.

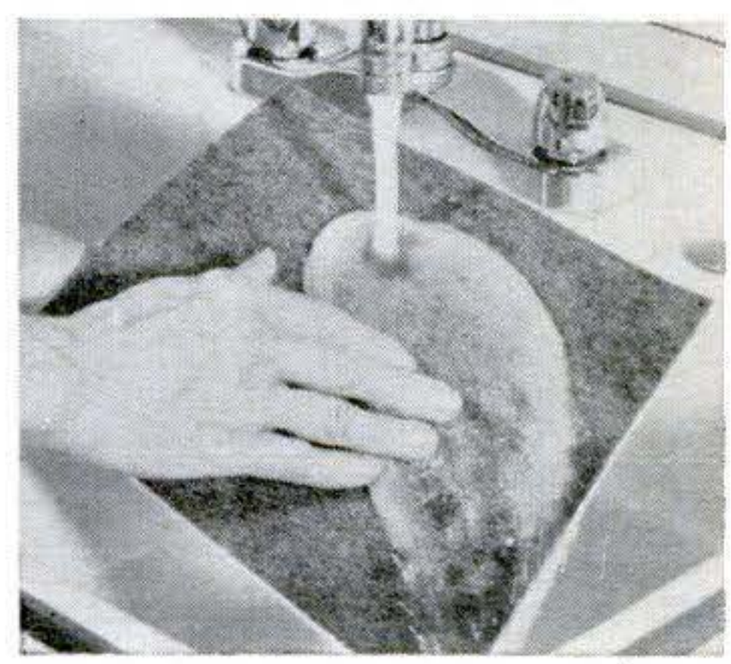


◄ Old-world look

A new idea for an old look is this old-world plywood paneling by Georgia-Pacific. Textured and factory-finished, the paneling is designed to provide the proper atmosphere for a period room. It's available at building-supply dealers in four wood types: pecan, oak, cedar, and birch.

Wash-'n-wear tiles ►

Now you can wash your carpet as easily as you wash your clothes. The special adhesive back (by 3M) on Ozite's carpet tiles enables you to pick up, clean, and replace a tile any number of times without destroying the bond. Tiles come in nine- and 13-inch squares, and in a wide choice of colors.



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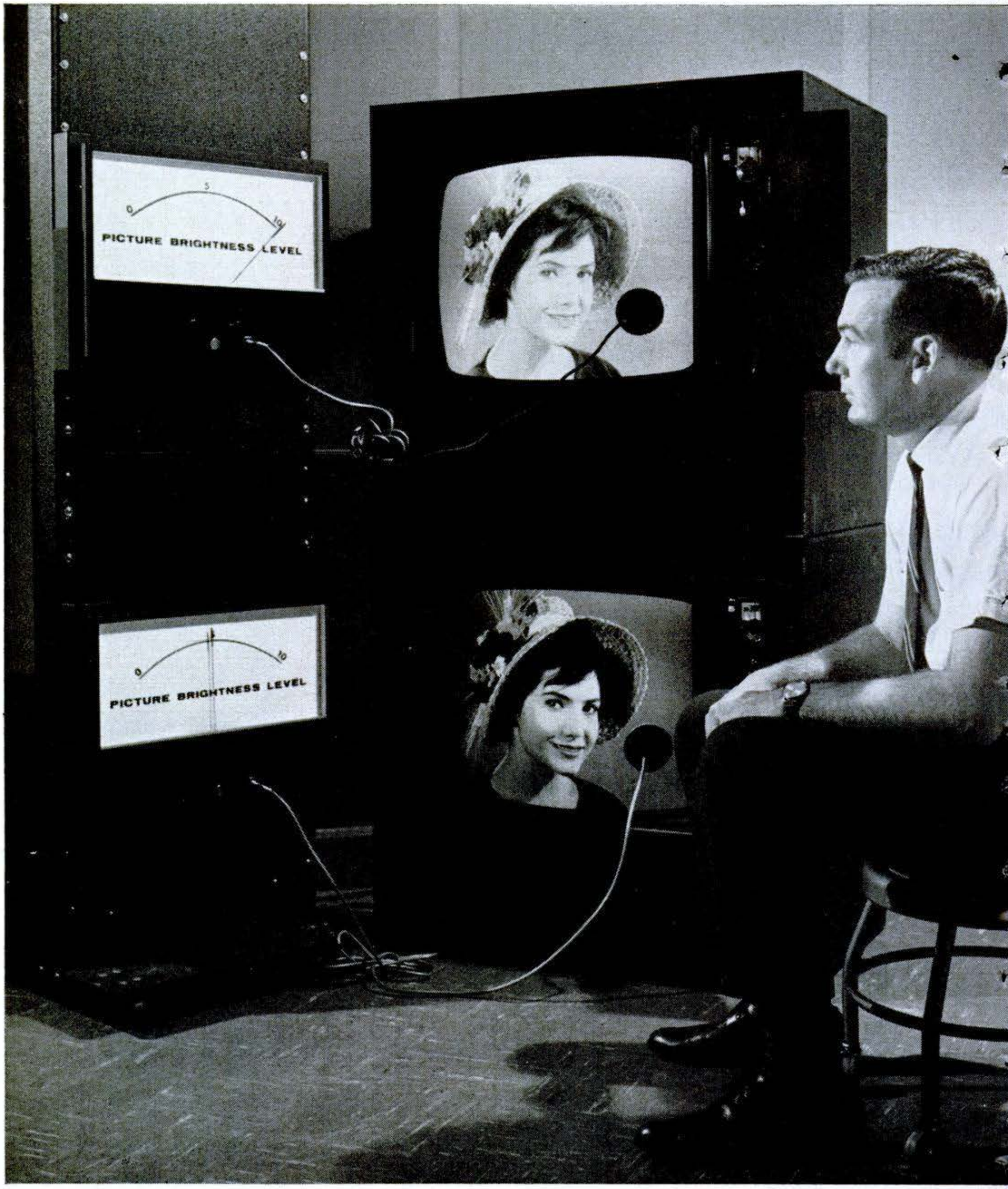
1970 COLOR TV: The Picture Is Brighter



Brightness level of RCA's new Hi-Lite color tube is demonstrated by giant meters above. Sensors placed on face of new tube (top) and previous tube (bottom) show that picture on new tube is twice as bright.

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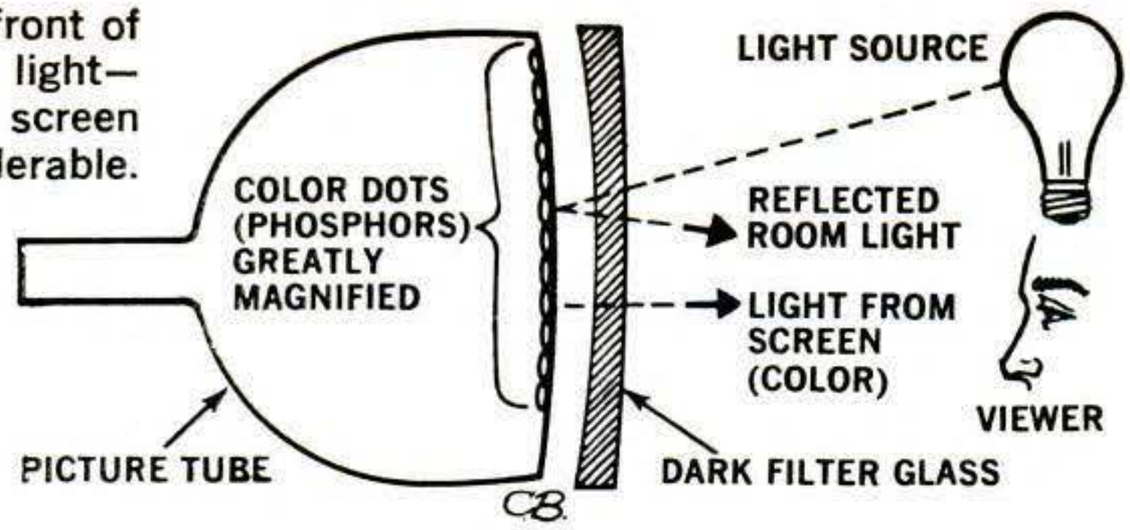
problem for tube designers was the filter glass in front of ventional screen. It reduces the effect of room light—ected room light passes through the filter twice, screen t only once—but loss of screen light is still considerable.



Than Ever

The big news for '70: brighter-than-ever screens, more automatic features, and no more click-click when you change channels

By LEN BUCKWALTER

Images twice as bright, color that adjusts itself—these are the two big electronic advances you'll find in the 1970 sets. The engineers aren't opening the decade with any spectacular breakthrough, but there's plenty of solid improvement to boast about. The new sets are simpler to adjust, easier to view in room light, and should surely take fewer trips to the repair shop.

This is also the year the optional accessory is becoming standard equipment. And you'll find costly features in moderately priced sets. For example:

AFT. A boon to touchy color reception, automatic fine tuning snares a station after a casual twist of the channel knob. As more sets get AFT, tuning aids like meters or magic eyes are disappearing.

ADG. This is the automatic degausser, often called the color purifier. It's a harness of wire around the picture tube that delivers an electrical jolt to demagnetize the tube and prevent false color in a black-and-white image. In earlier models you

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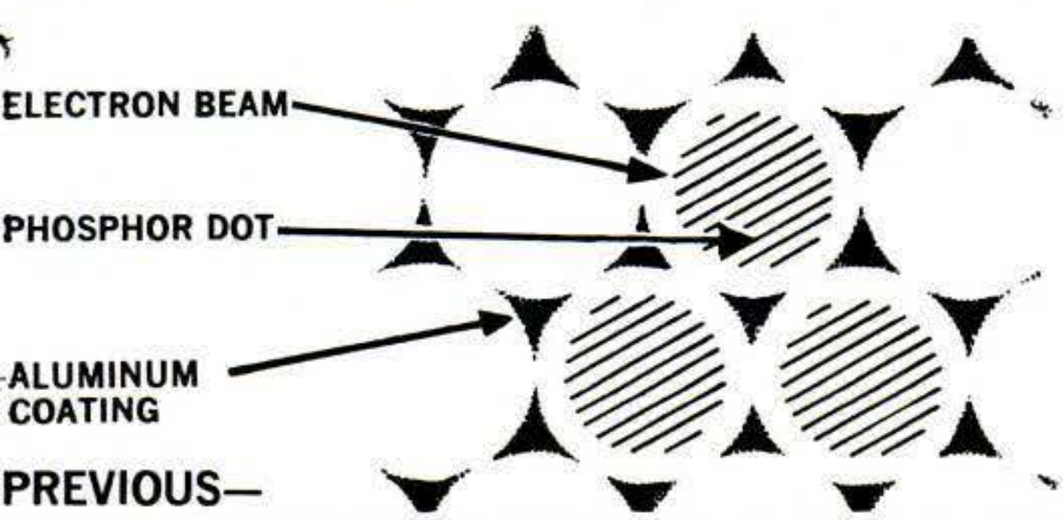
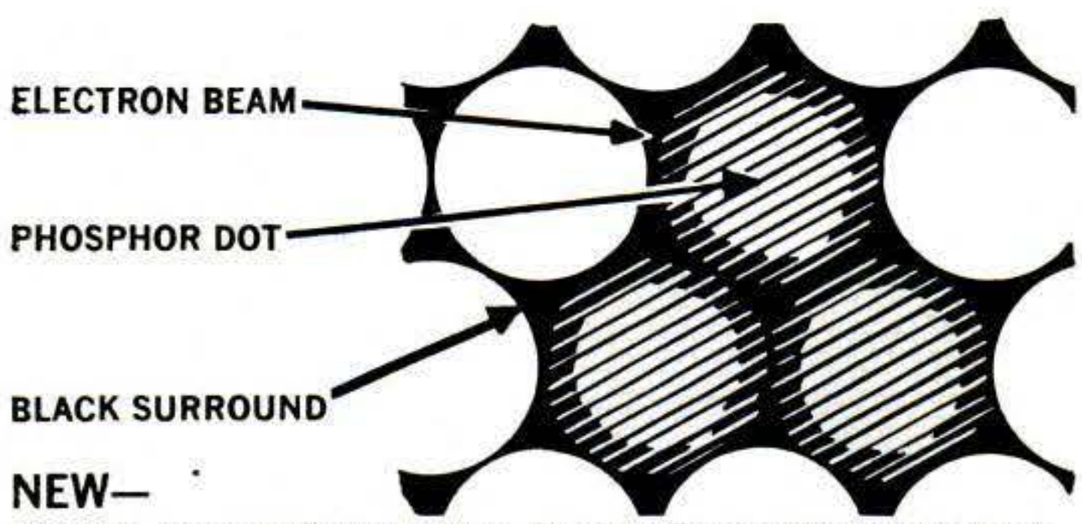


PREVIOUS—
LARGE PHOSPHOR DOT, SMALLER ELECTRON BEAM



NEW—
LARGE ELECTRON BEAM, SMALLER PHOSPHOR DOT

How Zenith increases brightness: Conventional screen (above) can be washed out by room light. By reducing size of phosphor dots (right) and surrounding them with black pigment to absorb outside light, less light was reflected back to viewer, and a more transparent filter (below) could be used.

Old and new filter glasses are compared above. Old glass, at left, cuts light transmission severely. New Zenith high-transmission glass, at right, lets more picture light through to the viewer.

Copyrighted material

had to call the serviceman for degaussing; now you can do it yourself each time the set is turned on.

Rare-earth phosphors. Almost any set you buy now has them. They're tiny chemical dots on the screen that glow with color TV's three primary colors: red, blue, and green. Early red phosphor was inefficient, so blue and green had to be throttled back to match it. The new reds can hold their own.

Besides the general upgrading, today's sets have their share of innovation that could become tomorrow's standard. Take a look at the "brightness race," for example.

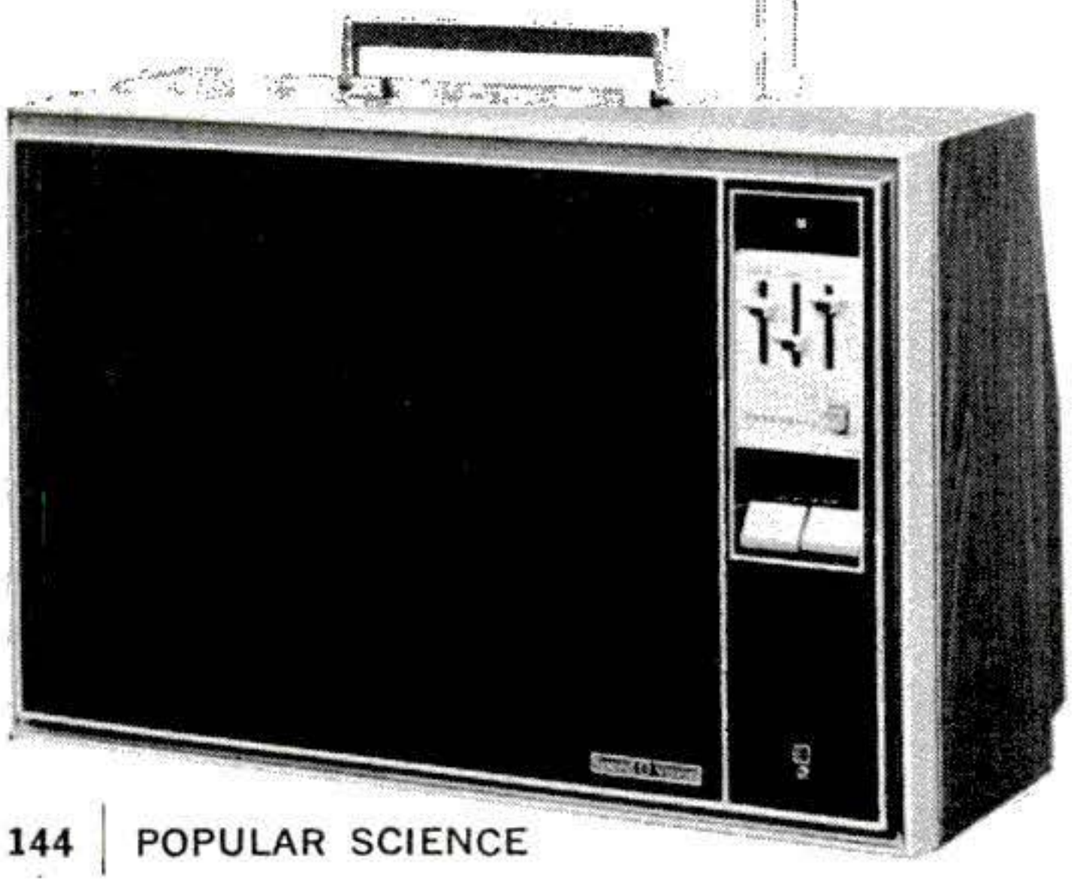
Those rare-earth phosphors just mentioned vastly improve TV images, but setmakers have an insatiable appetite for more color brightness and contrast. The reason: Color simply doesn't deliver the visual punch of black-and-white, and room lighting can wash out delicate hues. And with more color portables, there's also the matter of more viewing in broad daylight. So designers have had to come up with ingenious ideas to make color for 1970 "twice as bright."

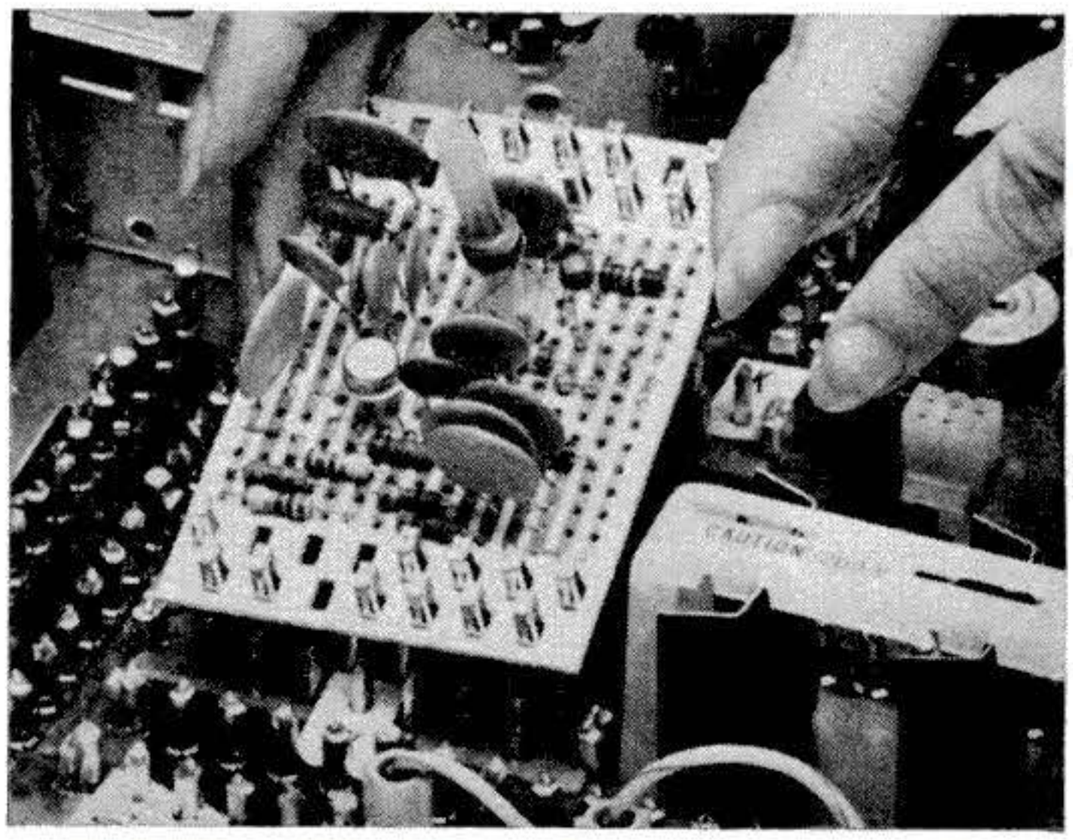
The filter-glass problem. Our simplified drawing of a regular color tube (previous page) shows a major trouble spot. It's the dark filter glass placed in front of the color screen to reduce the effect (poorer color and contrast) of outside light. Outside light must make *two* trips through the filter; screen light (the color program) makes only *one* transit through the dark glass. So the filter does improve color and contrast by knocking down extraneous light—but it also takes a heavy toll in color performance. Useful screen light is reduced by about a half.

Now look what Zenith does in its Chromacolor tube. For one thing, it shrinks the size of the million-odd color dots on the screen so that they're now surrounded by empty spaces. Into this newly opened territory is deposited a jet-black pigment that swallows any light that strikes it. This novel combination of small dots and black space wins a significant advantage: A whopping amount of outside light is absorbed by black areas of the screen. With less annoying light reflecting back to the viewer, Zenith can install a lighter, more-transparent glass filter in front of the screen. Color now comes through with greater intensity—and it resists washout from artificial and outdoor light.

With smaller dots, shouldn't there be proportionately less color? There would be, if Zenith engineers hadn't juggled another item in the tube—the shadow mask. This is a steel plate, punctured with a myriad of tiny holes, just behind the screen. Its job is to channel the electron beams that prod the color dots into producing light. As the beams ride through holes in the shadow mask, they land squarely on their assigned red, blue, and green positions. Zenith now widens those holes in the shadow mask to permit larger beams to strike the color dots. Thus de-

Controls without mechanical contacts change channels on this Panasonic b&w. Sliding levers adjust volume, contrast, and brightness.





Trend toward modular design is illustrated by Zenith Dura-Module, an interconnection system that takes any combination of components in any circuit.

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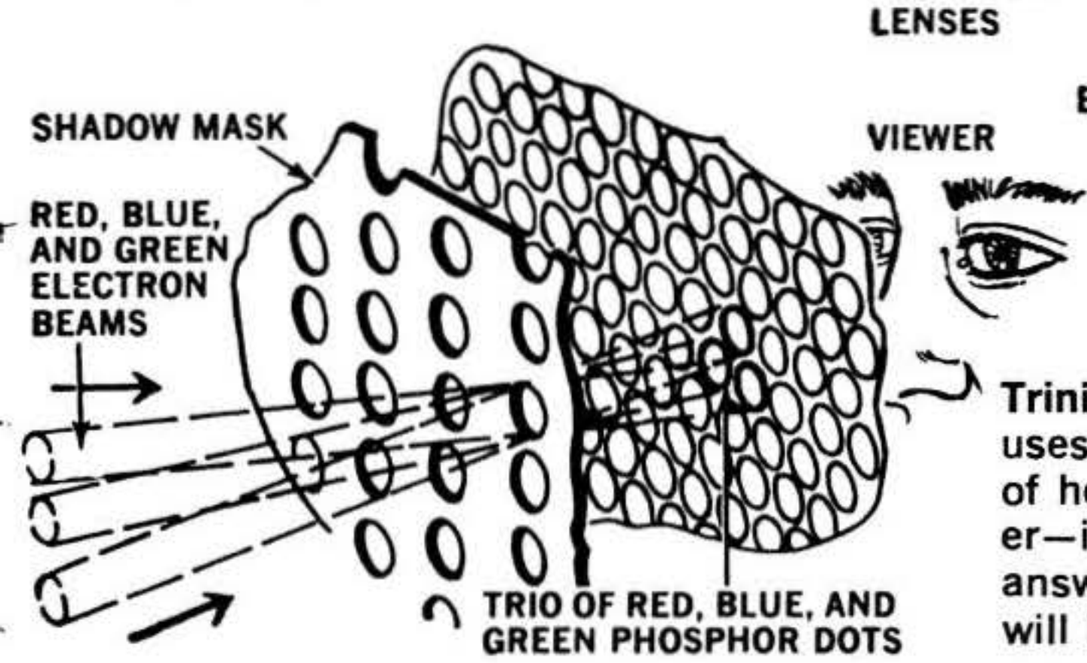
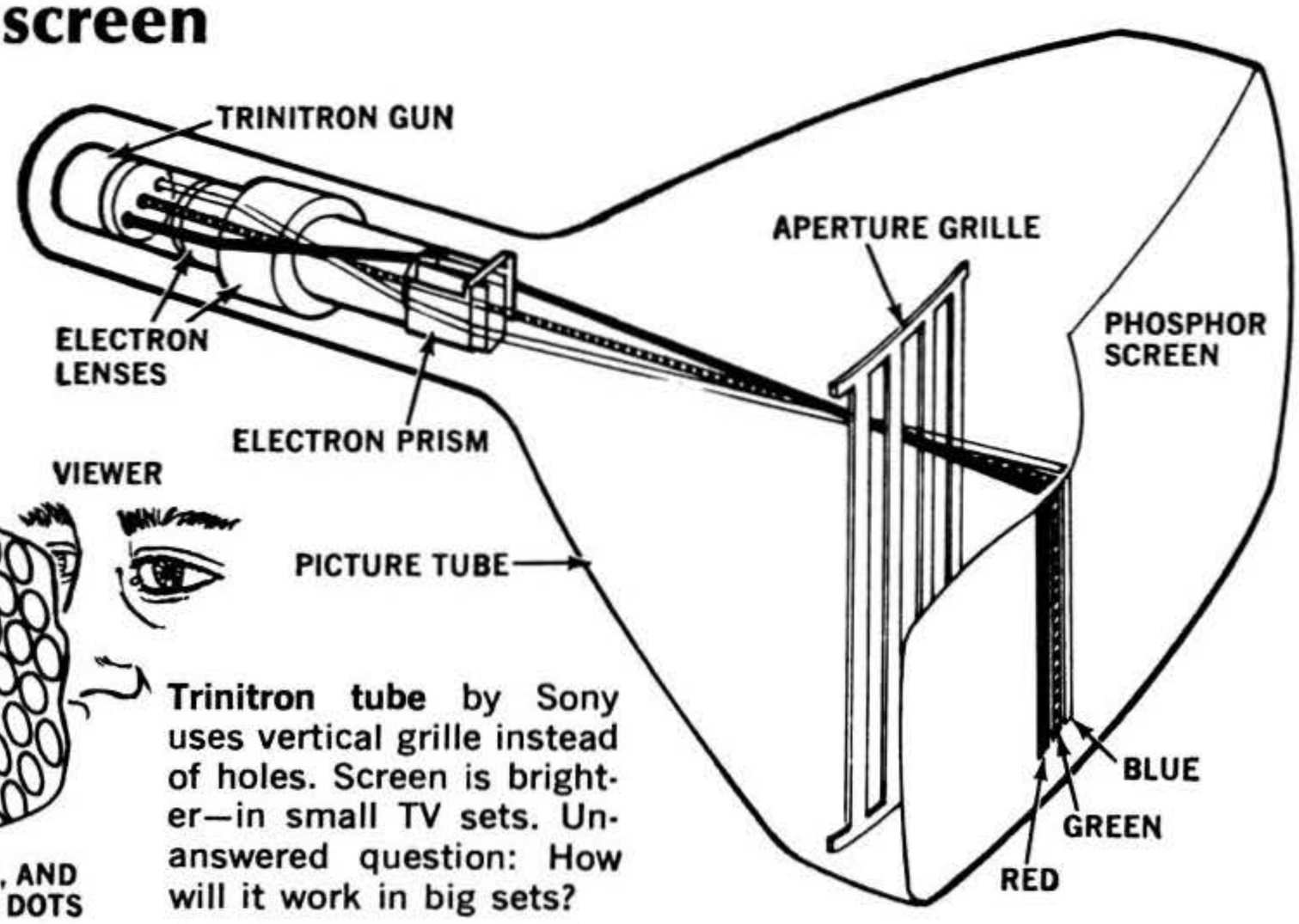
any channel on the screen

Conventional shadow mask steers electron beams through holes to color dots on screen. A necessary evil, unfortunately it reduces the screen's "transparency."





Trinitron tube by Sony uses vertical grille instead of holes. Screen is brighter—in small TV sets. Unanswered question: How will it work in big sets?

spite their smaller size, they still glow with the same intensity as before.

Another contender for the brightness race is RCA, with its Hi-Lite Matrix picture tube. Color dots are deposited on an opaque, black background to absorb undesirable room light, thus making possible a lighter filter glass in front of the screen—and a brighter image.

RCA has also improved the tube's electron gun to fire sharper beams at the screen. The net effect is a brighter picture of crisper focus. The new tube will also have RCA's Perma-Chrome shadow mask. As any color tube warms up, the shadow mask absorbs heat, expands, and moves slightly. A thermostat in the Perma-Chrome tube nudges the mask back into place and maintains correct alignment of its holes.

Enter Trinitron. That shadow mask is a necessary evil in color tubes that engineers would rather do without. Although it does the essential job of keeping colors pure, it reduces the screen's "transparency." There have been several efforts to get rid of the mask completely, and now someone has almost done it.

The Trinitron tube by Sony [PS, Nov. '68], being introduced to the U.S. in a 12-inch portable, is the first major change in color tubes to reach mass production. It abandons the regular shadow mask in favor of an "aperture grille."

In a conventional shadow mask, the beam keeps shifting sideways as it scans, activating trio after trio of color dots. During the shift, the shadow mask blocks the beams; only when the beams line up at the next hole can they pass through and reach the screen. This system keeps the traveling beams from sloshing the wrong colors on the screen. But the holes also cut the strength of the beams and hold down color brightness—which is the shadow mask's problem.

The Sony approach scraps a regular shadow mask in favor of the grille—vertical stripes rather than dots. The grille structure is much more open to electron beams and the image is, indeed, bright. Sony's color holds up very well under strong illumination.

Any drawbacks? Some observers are reserving final judgment until the new tube is made in big-screen sizes. In the 12-inch portable, the screen structure isn't apparent unless viewed at very close range. But will those vertical-stripe phosphors look coarse to the viewer in, say, a 23-inch set?

Hint of tint. The industry is also scoring notable gains in the matter of purple faces. Someone, finally, has come up with an automatic tint control. Magnavox [PS, Sept.] now equips some new models with ATC to eliminate a nagging need to readjust the set's tint control each time the studio changes cameras or inserts a video tape, or when you change channels. During these switches, flesh tones on actors may vary anywhere from gorgeous green to malevolent magenta. The Magnavox

[Continued on page 224]

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New horsepower champ! This Mercury delivers a mighty 135 hp. from six cylinders in line, making it the world's most powerful production outboard.

The Mercury 400, above, is a 40-hp. twin. It has capacitance-discharge ignition, comes with manual or electric start. An alternator is optional.

Most powerful Johnson, a 115-hp. V-4, powers a Magnum Marine Missile. The Sea Horse 115 has a 96.1-cu.-in. displacement and weighs 252 pounds.

Mercury's 7½-horse twin is a fisherman's special. Besides Maker-Point ignition and Perma-Gap plugs, it has a tilt position for shallow-water trolling.

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The '70 OUTBOARDS:
More Power, Convenience, Reliability

PS looks at the leaders. Verdict: no breakthroughs, lots of more-for-your-money improvements

By **JIM ROE** / *PS Boating Editor*

We haven't hit the top yet in horsepower. Now there's a 135-hp. outboard motor. At the same time, these sophisticated pieces of machinery we used to call "kickers" have been made more efficient and dependable.

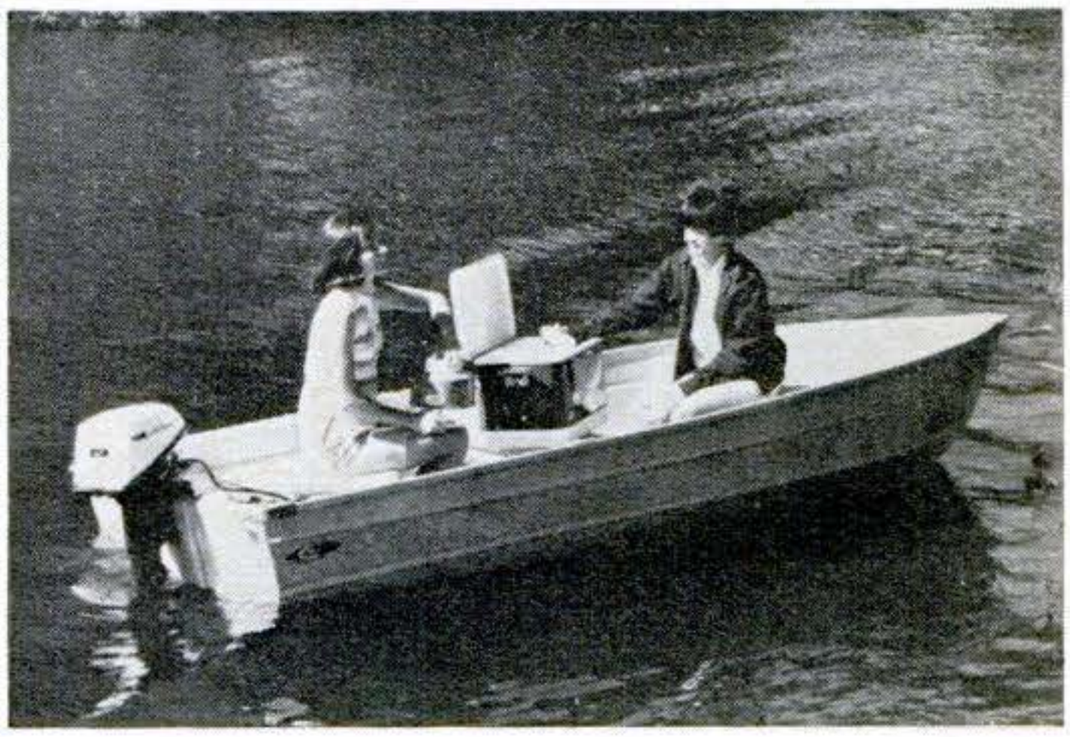
It should surprise no one that that 135-hp., 99.8-cu.-in. engine—claimed to be the "world's most powerful production outboard"—carries the Mercury name. Direct charging, introduced last year on the Merc 800, is given much of the credit. According to Mercury engineers, this unique design of transfer passages, ports, and pistons results in more precisely controlled induction of fresh fuel-air charges and exhaust of burned gases.

Mercury has announced two other new models for 1970. One is a 115-hp. six-in-line motor. Like the 135-hp. model, it has heavy-duty crankshaft bearings for greater reliability and performance.

Their other new model is the 40-hp., 33.3-cu.-in. Merc 400. Like it's biggest brother, it develops, says the maker, more horsepower per cubic inch than any other outboard in its class.

Mercury's 1970 lineup includes 10 models from four to 135 hp. All use Perma-Gap spark plugs—a surface-gap type with an erosion-resistant center electrode. Engines from four to 20 horsepower have Maker-Point Thunderbolt ignition, which reduces arcing (and therefore point erosion) by firing spark plugs when points close instead of when they open. Mercs from 40 hp. up use this breakerless ignition, an electronic capacitance system.

Johnson. Last year Johnson's big news was a pair of V-4s—one 115, the other 85 hp. New for 1970 is a three-cylinder loop-charged 60-hp. outboard. Its 49.7-cu.- in. displacement is the same as last year's 55-hp. motor. The increased output comes from a third intake passage (called a power port) in the cylinder sleeve, higher



Little 6-hp. Johnson powers fishermen, inflatables, dinghies; makes fine auxiliary for small sailboats. Like all 1970 Johnsons, it has a white and green housing.

Johnson Sea Horse 25, 22-cu.-in. twin, weighs 82 pounds. Starter interlock, just added, prevents starting in gear at advanced throttle settings.

New 60-hp. Johnson with three cylinders has a high output for 49.7 cubic inches. For quieter operation it has offset wrist pins to reduce piston slap, and has air intake port at the rear of the motor cover.

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Strictly for racing, Chrysler's 135-hp. engine will have limited production. Sexy exhaust stacks help it kick out 1.39 horsepower per cubic inch.

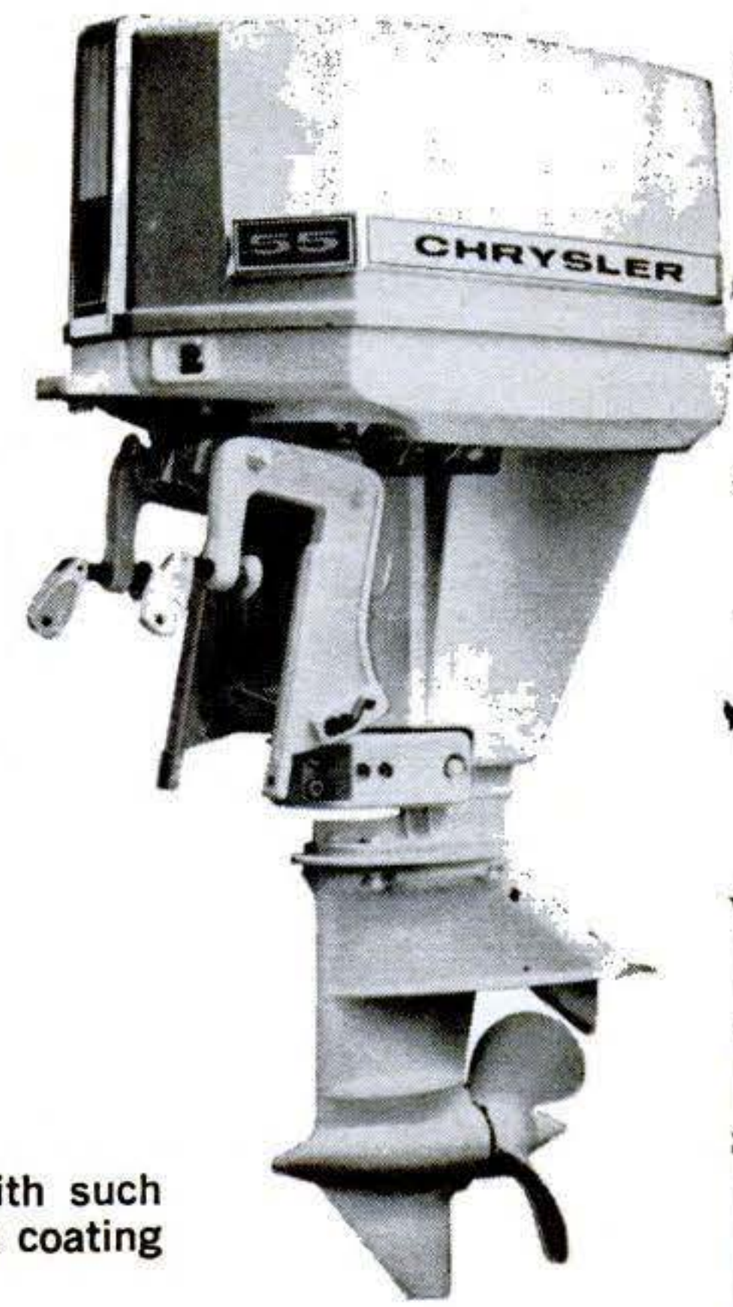
Big Chrysler 120 is a high-compression four-cylinder outboard motor suitable for offshore fishermen, family cruisers, and water skiers as well.

compression ratio, and easier breathing.

Engineering improvements appear, too. One is the Hydro-Electric Drive, a single-lever remote-control unit fastened to the boat with three screws. It shifts, changes speed, varies the idle and choke settings, warns of overheating, and has an on-off key switch. An adjustable friction brake holds the throttle where it's set, easing driving strain.

A new triangular Pressure-Back piston ring uses combustion-gas pressure to force the ring against the cylinder wall for better sealing. Johnson engineers say this ring,

Chrysler's 3.6 hp. is new for 1970. The featherweight single has 360-degree pivot steering and a side-mounted throttle lever for easy accessibility. A built-in fuel tank holds seven pints.



Chrysler 55-hp. outboard is a high-performance motor with such features as a corrosion-resistant finish, dielectric protective coating on all electrical terminals, and a no-drip carburetor.

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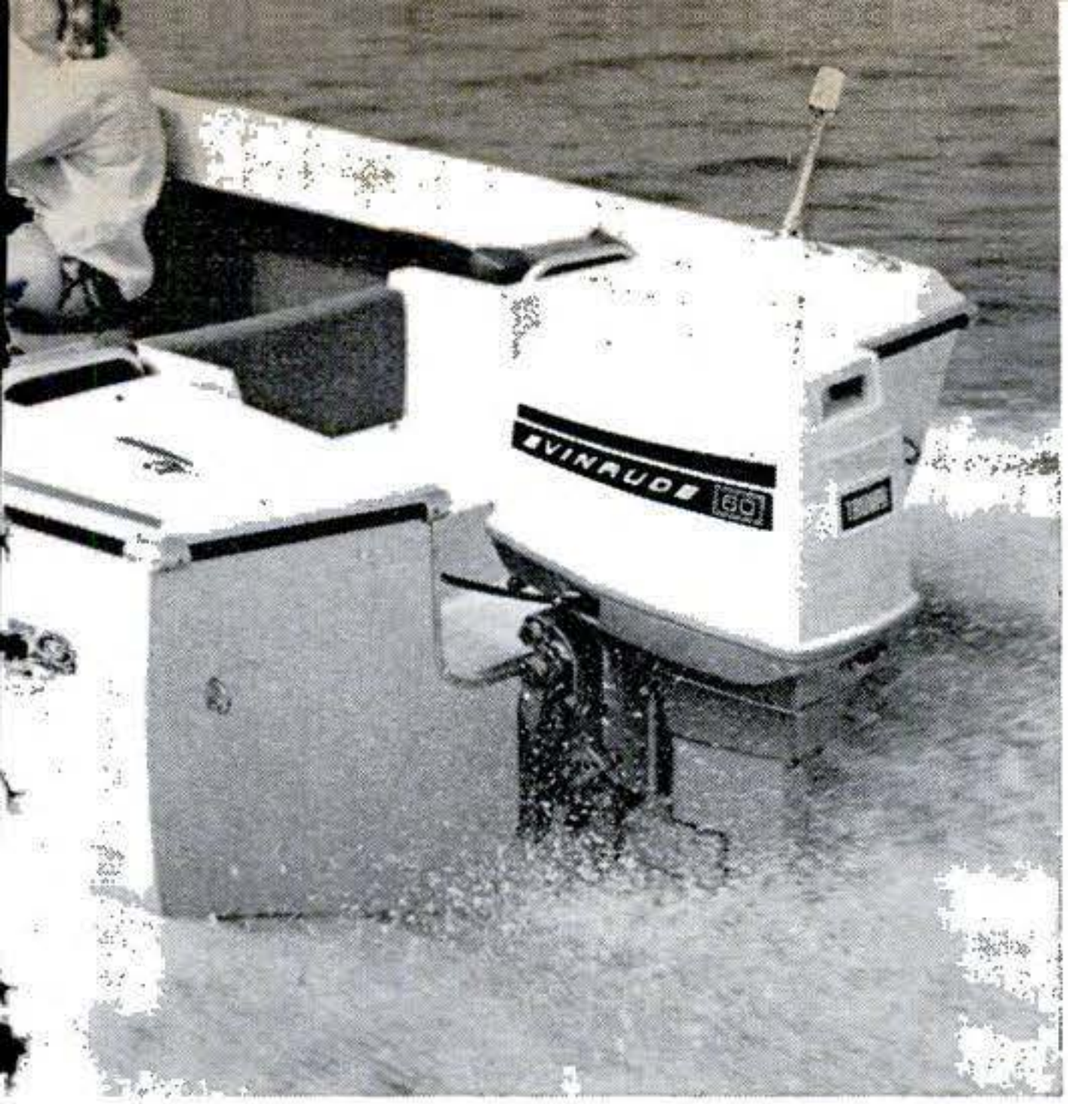


Evinrude Triumph, new for 1970, is a 60-hp. three-cylinder engine that weighs 207 pounds. It has three carbureters with fixed high-speed jets.

never used before in a production outboard, also reduces carbon buildup and piston-ring sticking.

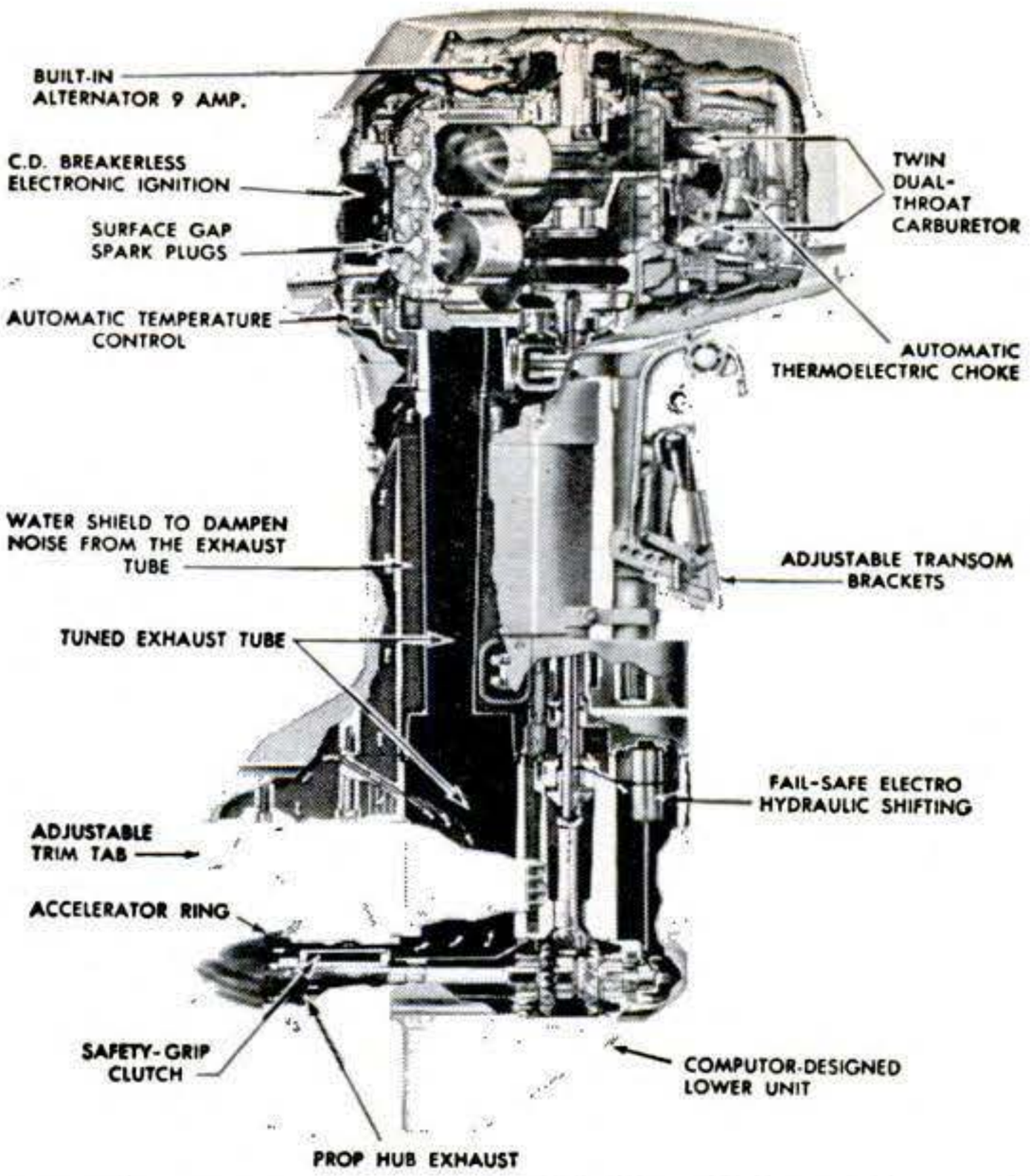
Chrysler. Top-of-the-line for Chrysler in 1970 is a new 120-hp. four-cylinder high-compression engine. Its molybdenum-filled piston rings are said to reduce cylinder-wall friction and scuffing. A capacitor-discharge ignition system (Magnapower) improves acceleration and starting. The 120 comes with standard or long shaft, and in a racing version.

Chrysler offers, astonishingly, 43 different models for 1970, beginning with a brand-new 3.6-hp. model. This single-cylinder featherweight pivots 360 degrees and has a built-in seven-pint fuel tank and dripless carburetor for nonspill toting and storage. Then there's a limited-production 135-hp. racing outboard, introduced recently. Outboard Boating Club of America certifies that this special motor develops more than 1.39 hp. per cubic inch of displacement.

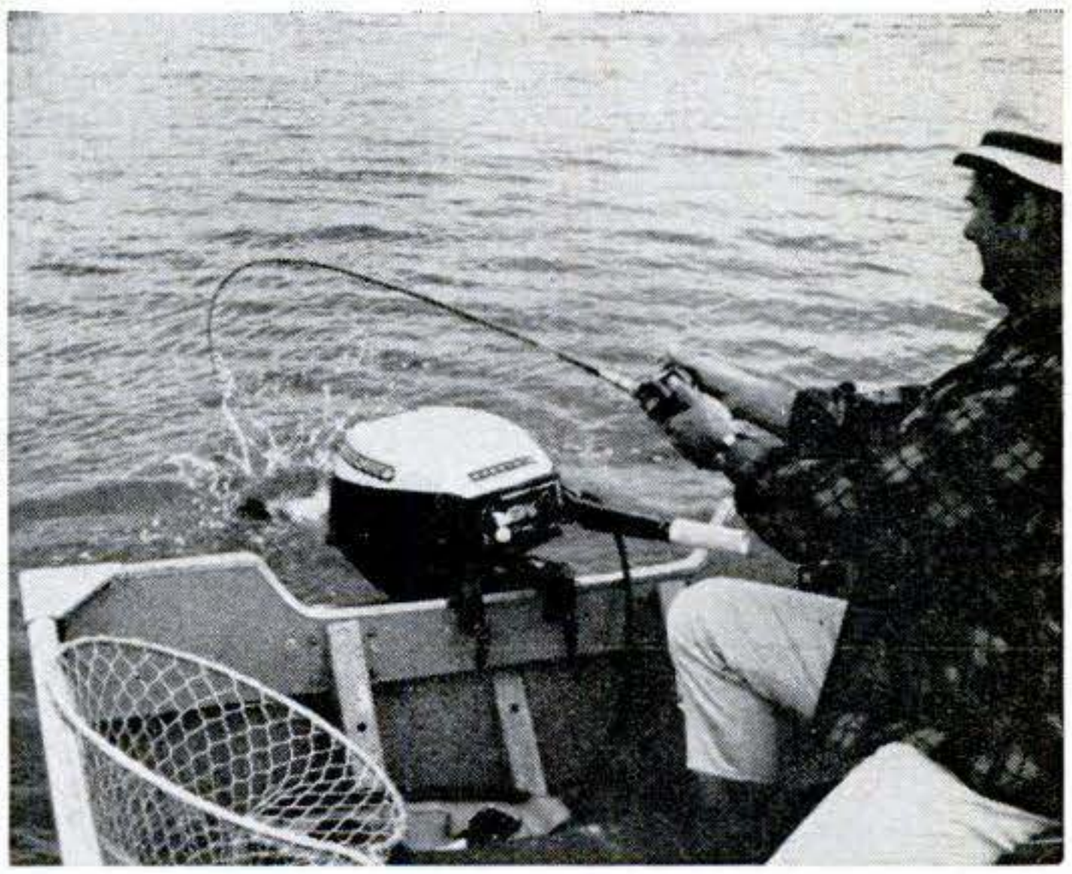
As an accessory, Chrysler offers an anticorrosion kit called Chrysler-Capac. Its electrics are entirely solid state, and the system can be installed on any outboard or inboard.

Evinrude. For 1970 there are 15 Evinrudes in 11 different power ranges from 1.5 to 115 hp. The biggest—115 and 85—are short-stroke V-4s. The 60-hp. Triumph has three cylinders in line, and all others except the 1½-hp. single are alternate-firing twins.

The Triumph's five-horsepower increase over last year is the result of a third intake port, a new Pressure-Back piston, and



Inside story of Evinrude 115-hp. V-4 is shown in drawing above. Big boy of the Evinrude line, it has a 96.1-cu.-in. displacement, weighs 252 pounds.



Evinrude Sportwin, popular 9½-hp. trolling motor, weighs 60 pounds, has forward-neutral-reverse shift, and can be fitted with optional remote controls.

a bigger air-intake silencer. Electrohydraulic shifting, first offered on the 115- and 85-hp. models last year, is now available on the Triumph.

Some niceties have been added to other models. A starter interlock on the 18- and 25-hp. models prevents racing the engine in neutral. There are new, stronger stern brackets and improved anticavitation plates. And the four-horsepower model has a new steering handle detent that keeps the handle upright over the motor's entire 300-degree pivot.

Whatever your craft, there's a '70 outboard ready and waiting for it. PS

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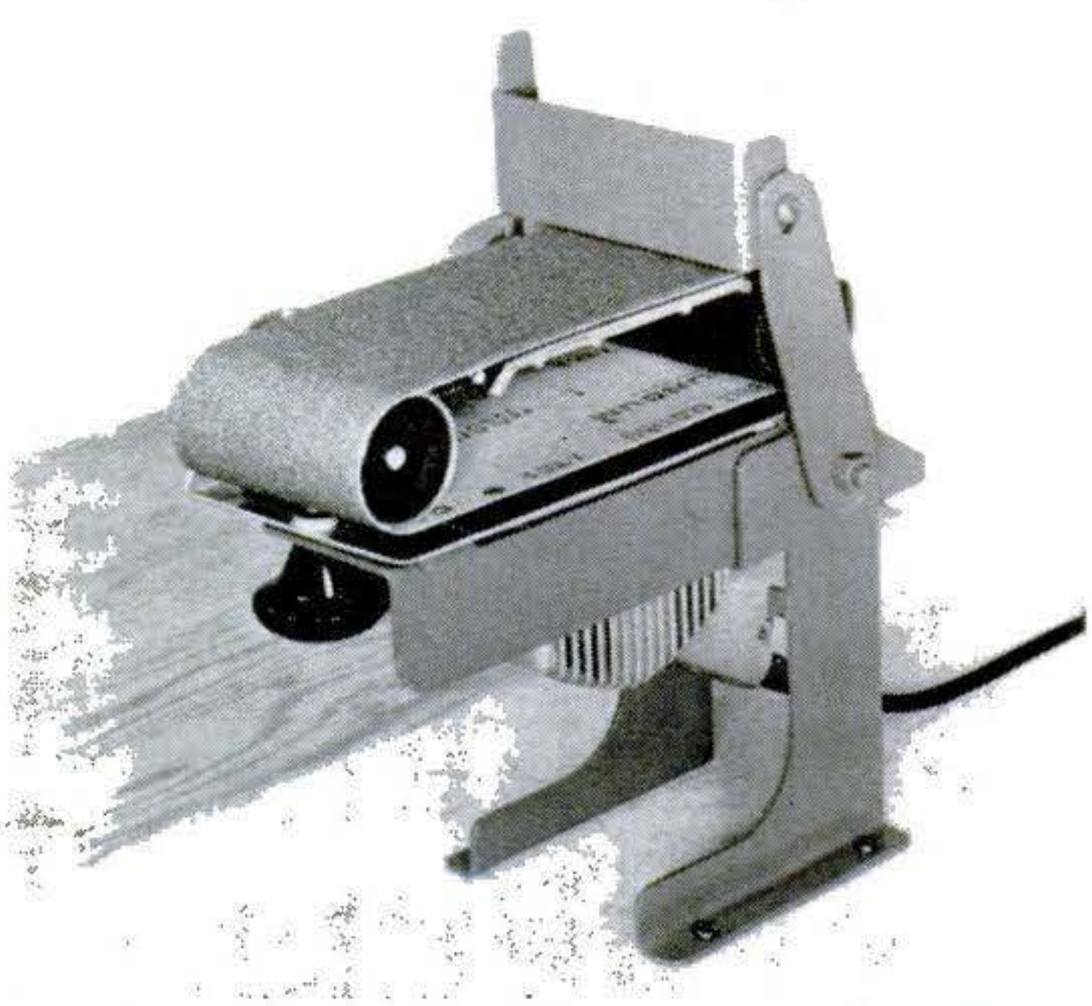
Compact design makes for easy handling

Reduced size and weight of modern sanders is coupled with increase in power and effective sanding area. This is Rockwell's shockproof Green Line model, available with or without a built-in dust collector.



Accessories convert the portables to other uses. Some companies offer a stand to upend their tool for stationary sanding of small, hand-held work; this is Portable Electric Tools' stand for their Shopmate.

Motor is between rollers in Black & Decker's low profile model, for improved balance and overhead clearance. This unit also boasts high and low speed for its 3" x 24" belt. Dustless accessory available

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The New BELT SANDERS
Smaller, Lighter, Tougher

Got a lot of sanding to do? Get acquainted with today's hard-working, easy-to-handle tools

By R. J. De CRISTOFORO

Today's portable belt sanders are to older models what the Maverick is to a Sherman tank—with one important exception: The compact modern sander can do the same job as those old giants.

Casual woodworkers used to be a little afraid of belt sanders. They were heavy, cumbersome, and—if you failed to wrestle them into submission—they could gouge up a board pretty fast.

No longer. Units that have become available in the last few years come in smaller, lighter, easier-to-handle packages. It's hard to choose between them. Most of them have greater power. Many offer a larger effective abrasive surface than old models. The latter doesn't always mean an increase in belt size; it may be achieved with a larger shoe—the platen that describes the area that makes contact with the work.

To grasp this, let's compare a four-inch belt moving over a four-by-four-inch shoe with a three-inch belt moving over a three-by-five shoe. Actual abrasive contact is much the same, so power requirements would be similar. The four-inch machine has to be bigger to house the wider belt, but the weight increase in today's large sanders isn't always startling; check the chart farther on. Stanley's four-inch sander is 3½ pounds heavier than their three-incher. The increase in the Millers Falls or Skil is only two pounds.

But you can't discount even that minimal increase if you have jobs that require extensive sanding on vertical or overhead surfaces, where the extra weight seems to increase in proportion to the length of work time.

Available speeds (in surface feet per minute) range from about 750 up to 1,450. The higher speeds seem to go along with increases in power and price. You'll get a better sander at the higher price, but you'll be buying it for more *productive*

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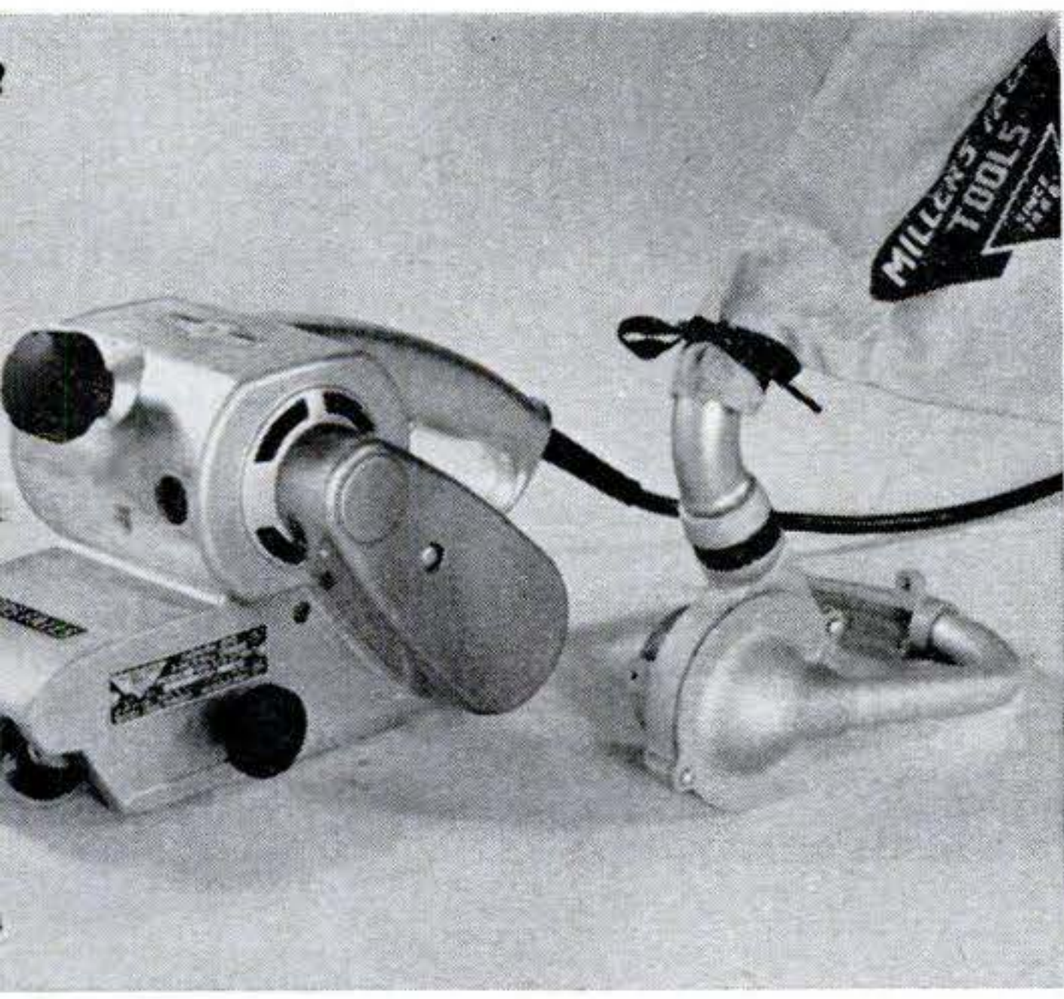

Dust collector at right of sander is an accessory that takes minutes to attach and then stays on Millers Falls Model 830. Large-capacity bag is easy to detach for emptying. Sander takes a 3" x 21" belt.

Different type of collector is hose in foreground—an accessory that hooks Stanley sander into any household vacuum. Machine takes 3" x 21" belt, has open-end housing for mounting thick Stanbrite belts.

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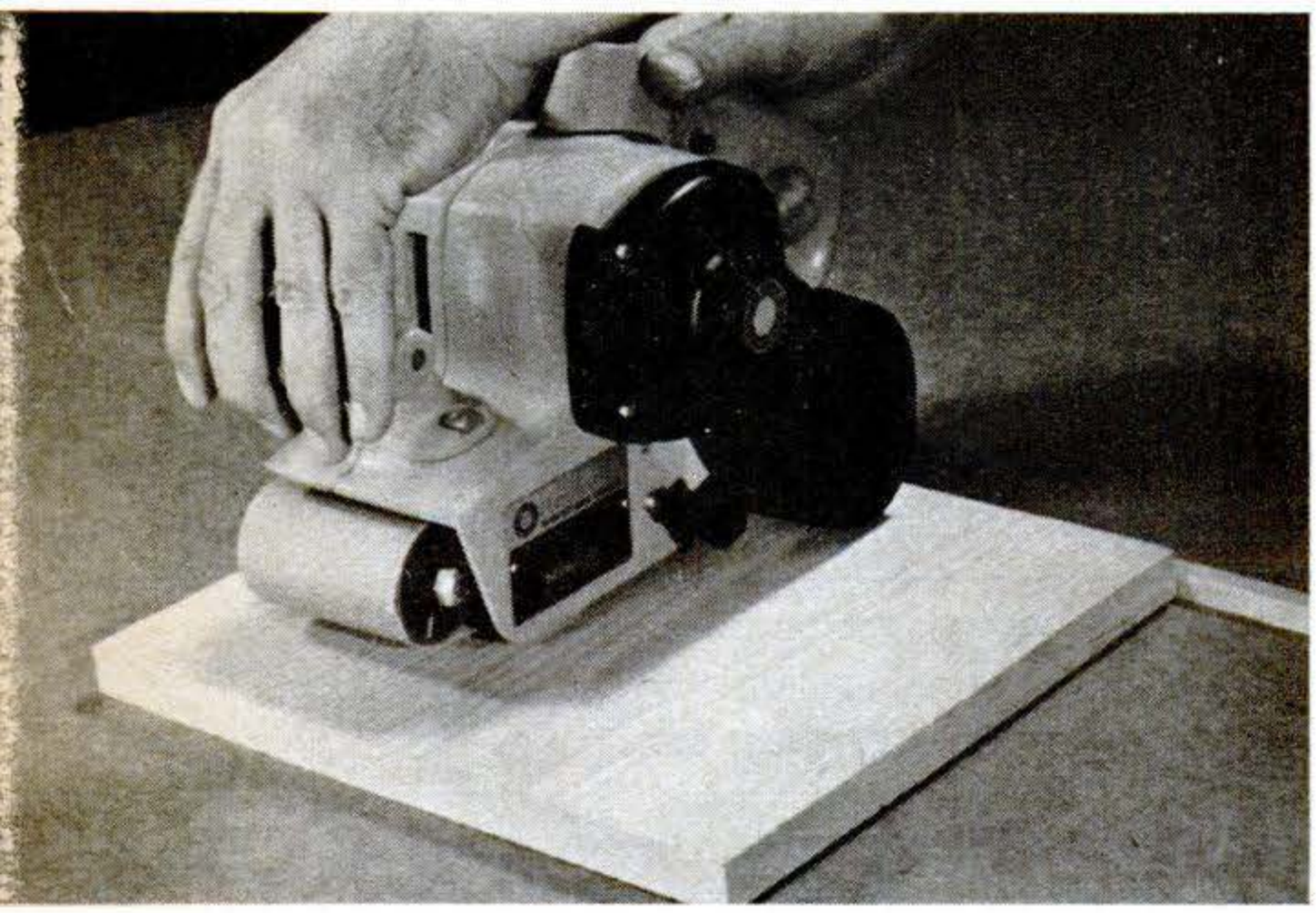
How not to sand edges—always keep your machine level. Tilting, as shown, will create slopes and broken edges and may even cut through face ply. When you come to ends of strokes, sweep tool away and up.



Use backup strip, tack-nailed to bench top, when sanding small pieces. If you don't, tractor action of belt will throw work back at you. Don't try to hand-hold such pieces—you could lose a fingernail.

With a little know-how you can do a variety of jobs

sanding, not *better* sanding. The 75 speed sander can do the same job as th 1,450; it just takes twice as long.

How about dual speed? The differen between "High" and "Low" settings two-speed models runs around 200 SFP —not a startling difference, but not to discounted. There are times you'll wa to move the machine faster without d creasing the amount of sanding done. Bu speed should not be the deciding fact in choosing a sander.

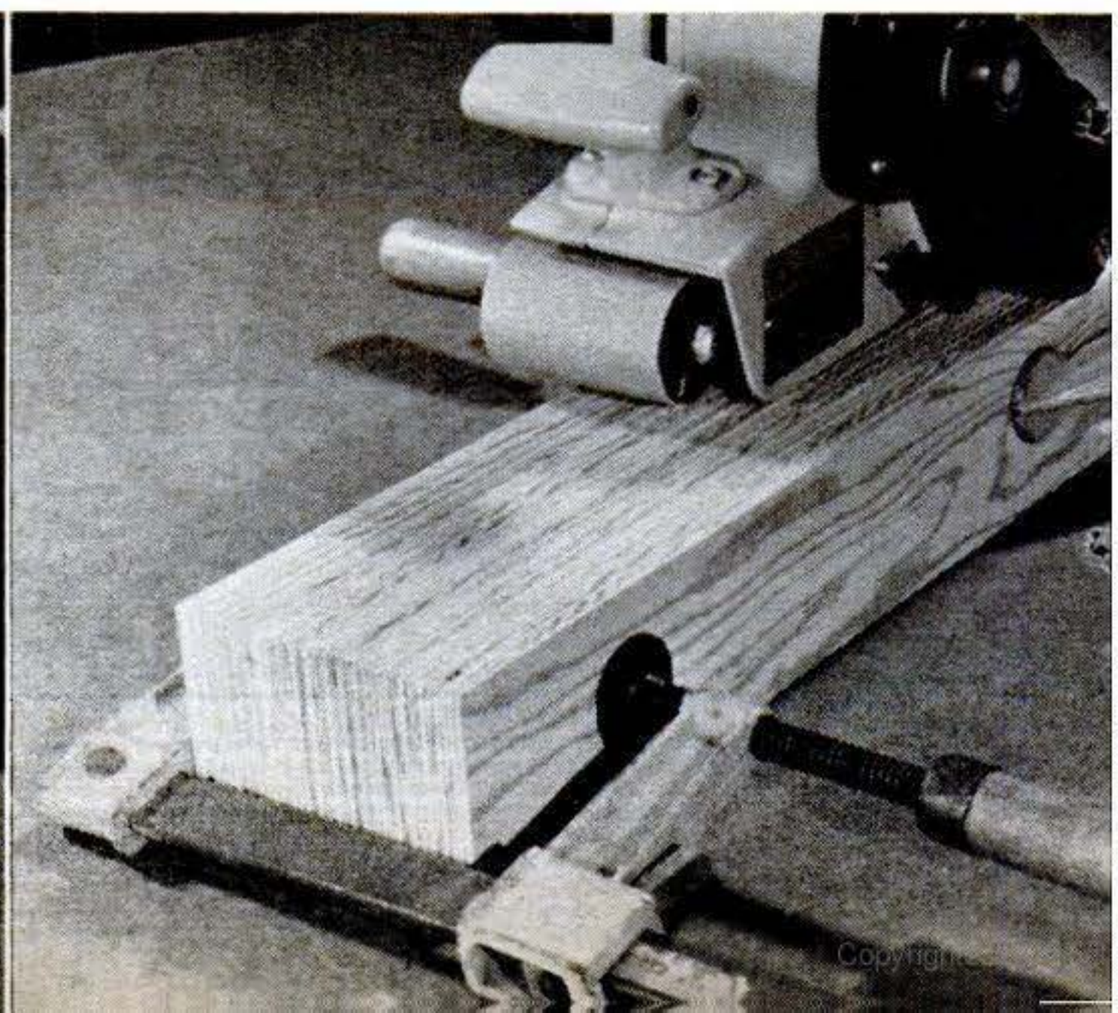
You'd have trouble buying a poor be sander. The junk manufacturers, fort nately, don't even try to make this too It must drive a fair amount of abrasiv material, each particle of which must cu away its share of wood. This heavy resi tance means the tool must have stead power and a sturdy frame. So all be sanders tend to be quality tools. Whe you pay extra money for one, you get mo power for faster sanding. Larger belts ma go along with the upgrade, but this significant only if the shoe area increase proportionately.

Even if price is no consideration, th top tag may not be best for the work you do because of the extra weight. Belt widt generally indicates a model's size/weight price category.

Other features to check. Some model have protrusions on the open side that pre vent use against a vertical surface. Thi means you can't sand flush to walls whe

Metal, too, can be surfaced with a portable sander. An aluminum-oxide belt will refinish scarred steel tool-table surfaces. Be sure to use the very finest grit that will do the job, and keep machine moving.

Edge-sanding goes quickly if you gang members wit edges aligned and clamp as shown—again usin backup strip. If only two or three pieces are needec space them apart with scrap to keep sander leve



BUYER'S GUIDE TO BELT SANDERS

Manufacturer	Model No.	Belt Size (inches)	Power (amps)	Speed* (no load)	Bearings	Weight (pounds)	Dustless?	Price
STANLEY	80-493	3 x 21	5.5	850	ball and sleeve	11	with accessory	$ 64.95
	80-494	4 x 24	9.0	1,350	ball and sleeve	14½	with accessory	110.00
ROCKWELL	91 & 90	3 x 21	6.0	900	ball and bronze	10	internal vacuum $10 extra	54.99
	336 & 337	3 x 21	7.0	1,300	ball and needle	9½		69.50
SKIL	594	3 x 21	5.0	925	bronze	9½	no	64.95
	595	3 x 21	5.5	925	bronze	10	yes	74.95
	405	4 x 21¾	7.0	1,350	ball and bronze	12	with accessory	97.50
	400	4 x 21¾	7.0	1,350	ball and bronze	13	yes	107.50
BLACK & DECKER	U-244	3 x 24	5.7	1,250	roller and ball	8¾	with accessory	69.95
			4.2	1,050				
	U-144	3 x 24	5.2	1,200	sleeve and ball	8¾	with accessory	49.99
MILLERS FALLS	830	3 x 21	6.0	1,300	ball and needle	11¼	with accessory	84.50
	840	4 x 21	7.5	1,450	ball and needle	13¼	with accessory	92.50
PORTABLE ELEC. TOOLS†	1860	4 x 21¾	8.0	1,400	bronze sleeve	12	with accessory	50.98
WEN	910	3 x 18	4¼	850	bronze sleeve	7	no	49.95
SEARS	99F2242	3 x 21	1 hp.	1,300	ball and sleeve	11	no	44.99
	99F2262C	4 x 24	1½ hp.	1,250	ball and needle	18	no	69.99
				1,500				
	99F2267C	4 x 24	1½ hp.	1,250	ball and needle	18	yes	79.99
				1,500				
THOR	555	3 x 18	2/5 hp.	750	bronze sleeve	6¾	no	42.00
				950				

†Div. of G. W. Murphy Ind. *in SFPM (surface feet per minute)

refinishing a floor, or up against vertical members in case goods. If that's an inconvenience, look elsewhere.

Methods used for belt changing and tracking vary, but all work quite well. To change a belt, you must decrease the distance between drums. On some machines, you do this by bearing down on the front drum until it clicks into hold-back position. On others, you use a lever. I prefer the lever since it lets me release the front drum slowly while visually checking the tracking position of the new belt. It's a moot point, though, since new belts invariably need some tracking adjustment.

Tracking is accomplished by turning a knob that angles the front drum until the belt runs straight, without movement to either side.

Tips on usage. If you set down a belt sander and flip the switch, it will travel like a tractor on treads; it won't do any sanding, but it sure will scoot. So the first rule is to start the tool *before* it contacts the work. Then keep it moving. If you hold it in one spot, you'll create depressions that are hard to smooth out. Work in strokes that parallel the grain, with an occasional short lateral motion so the main strokes are overlapped.

Hints on abrasives. Coarse, medium, and fine categories are good indications of the finish you'll get for average work, but here's a more specific guide for you:

GRADE	SOFTWOOD	HARDWOOD
Coarse	1½-1	2½-1½
Medium	1/0	½-1/0
Fine	2/0	2/0-3/0
Very fine	–	6/0

The most common abrasive is garnet, though the trend is toward aluminum oxide. It costs more initially, but is more economical in the long run.

"Open-grain" means less abrasive coverage of the backing to provide room for waste particles. Since it has less tendency to clog, it's best for finish removal and working soft, resinous woods.

Don't automatically reach for the roughest belt you have; instead, always use the finest that will do the job. This will minimize the with-the-grain work that must always be the final step. PS

Special belts and compounds adapt belt sanders for smoothing down finish coats or for polishing. Take care to follow manufacturers' instructions with these.

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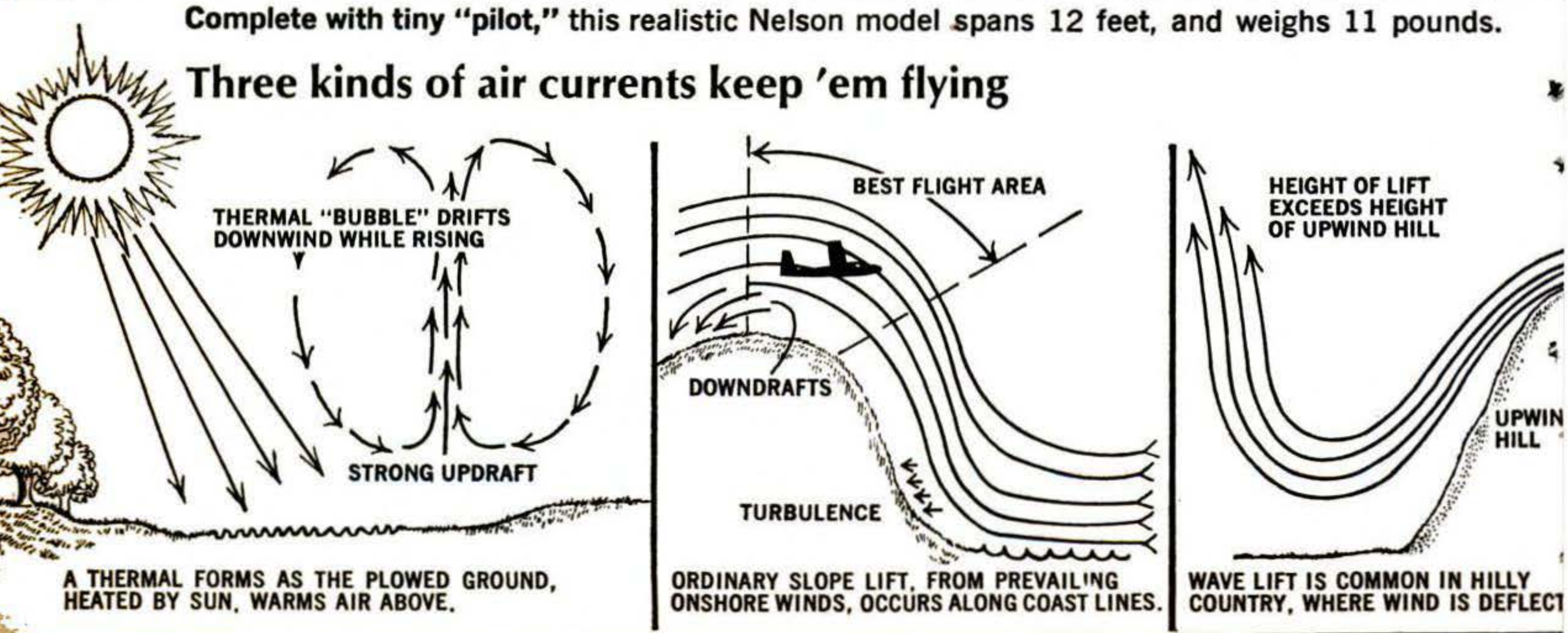
Now They're Flying

Complete with tiny "pilot," this realistic Nelson model spans 12 feet, and weighs 11 pounds.

Three kinds of air currents keep 'em flying



A THERMAL FORMS AS THE PLOWED GROUND, HEATED BY SUN, WARMS AIR ABOVE.

ORDINARY SLOPE LIFT, FROM PREVAILING ONSHORE WINDS, OCCURS ALONG COAST LINES.

WAVE LIFT IS COMMON IN HILLY COUNTRY, WHERE WIND IS DEFLECT

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Model Gliders by Radio

At a California meet, enthusiastic competitors launch slope-soaring gliders into strong onshore wind.

Off you go. A solitary flier tosses his T-tail glider off a breezy slope near popular Newport Beach.

Simple gear and a sharp eye for updrafts sends sailplanes soaring high, wide, and handsome

By HOWARD G. Mc ENTEE

Model enthusiasts who fly by flicking switches have a new bird to play with. Bigger—yet lighter—than a buzzing power plane, a glider soars silently on rising air currents. Two radio-operated controls guide it from the ground.

Finding steady breezes, updrafts, and thermals is half the fun of this new wrinkle in model flying. Developing the skill to use these air currents is the other half. The sketches, on facing page, show how currents get started.

Take-off. Model-glider pilots launch their craft in five ways, depending on air-current strength. When there's a stiff wind or powerful updraft they throw the glider into the air.

When surface lift is weak, they help the glider gain altitude and speed so that it will soar on the slightest breeze. Most often, gliders are boosted with a slingshot arrangement called "high start." A two-part line of nylon and rubber cord is stretched hundreds of feet between a stake in the ground and a ring hooked to the glider's fuselage. When the launcher releases his craft, the line contracts suddenly, catapulting the glider upward at a 45-degree angle.

Sophisticates use a "winch tow" for better-controlled launches and higher altitudes. An electric- or gasoline-powered winch pulls the glider into the wind a distance of several hundred yards.

Though purists frown, some glider fliers in flat country fit a small model engine atop the glider's wing. Running for about two minutes, it propels the glider to an altitude of about 400 feet. A few enthusiasts set their gliders piggy-back on power planes and fly them up. One pilot tows his model glider aloft with a model power plane.

Slope and thermal soaring. What a pilot does with his glider once it's airborne depends on the kind of lift available. Along the California and Atlantic coasts, where strong prevailing winds flow upward over rocky cliffs or dunes, lift is strong and constant. Slope-soaring gliders used here are flat-bottomed, heavier, and have shorter wings than those used for thermal soaring.

Slope-soarers will glide indefinitely as long as they're kept within a few hun-

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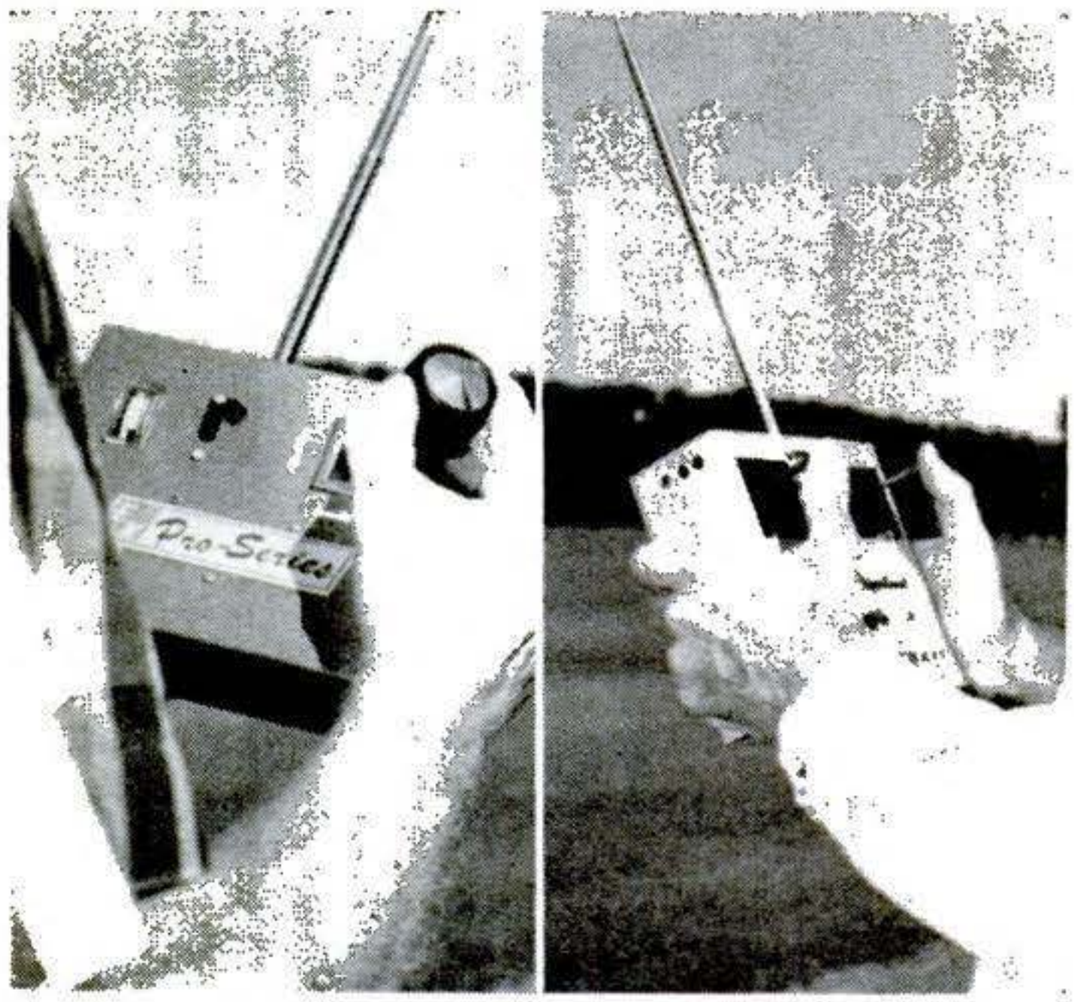
Michigan dunes offer good soaring currents. Two model fliers launch a Kurwi—a German kit glider.

Cape Cod beach has strong prevailing winds for this one-man launch from a 40-foot-high sand dune.

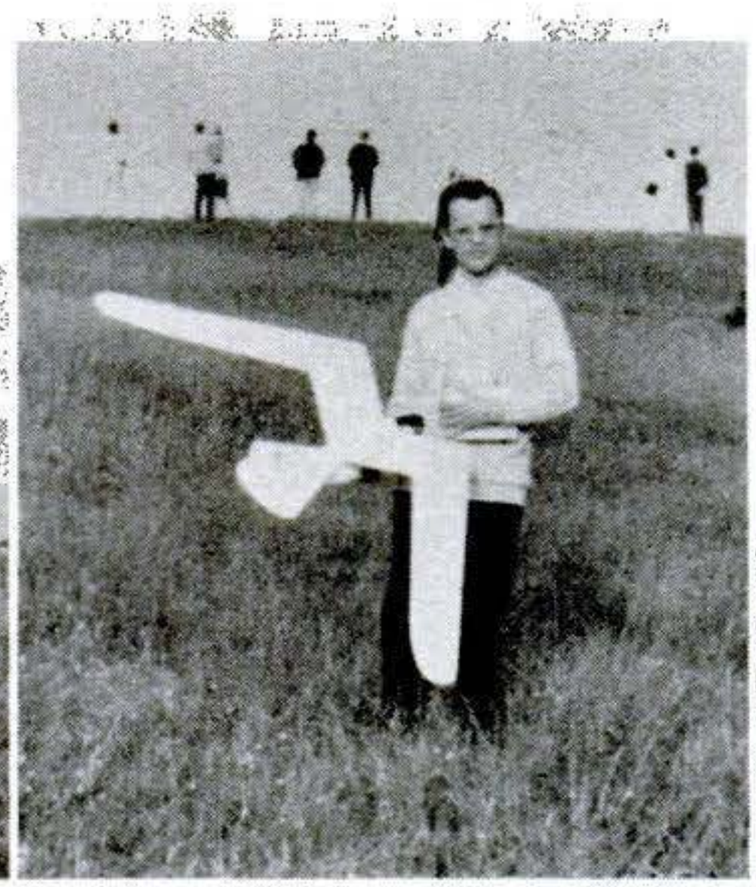


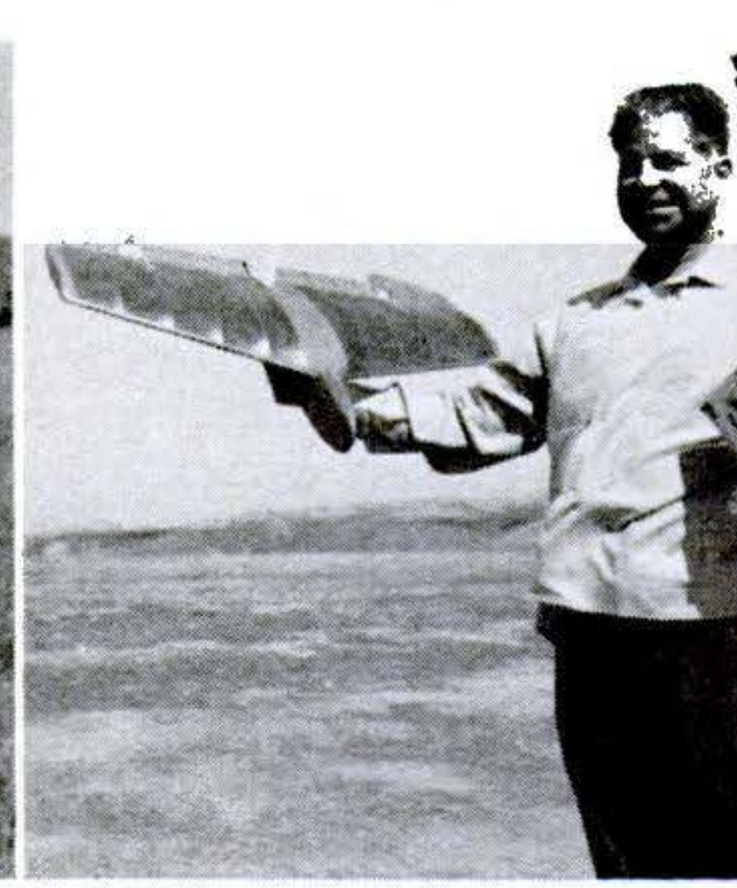
Radio controls come in single- and dual-stick versions. Single control (left) moves elevator with up and down motion, ailerons with sideways motion, rudder with a twist of the knob. Dual control (right) typically works rudder and throttle with the left stick, elevator and ailerons with the right stick.

dred yards up- or downwind of the cliff top. Some even do acrobatics—including spins, snap rolls, and loops.

Thermal-soaring gliders—used in flat or hilly country without strong prevailing winds—have large, deeply cambered wings and light bodies. Thermal soaring is trickier because lift often exists in relatively small areas—over blacktopped parking lots or ploughed fields, for example. A flight may last five minutes, or hours, depending on the pilot's skill in finding thermals. Though less dependable than slope lift, thermal lift can carry a glider much higher—often thousands of feet up.

Glider contests. European enthusiasts have a head start on Americans in model-glider competition, though the fever is spreading gradually from Southern California to the rest of the country, notably the Northeast. Pylon races, spot landing





Model gliders come in many shapes and sizes

Monster glider (left) is the Cumulus Zeus; it has a 137-inch wingspan. Wings are always removable to simplify transporting of gliders. Some enthusiasts design their own unorthodox craft. The bird-like glider (center) proved to be a fine performer. The flying saucer reportedly soars well in a slope lift.

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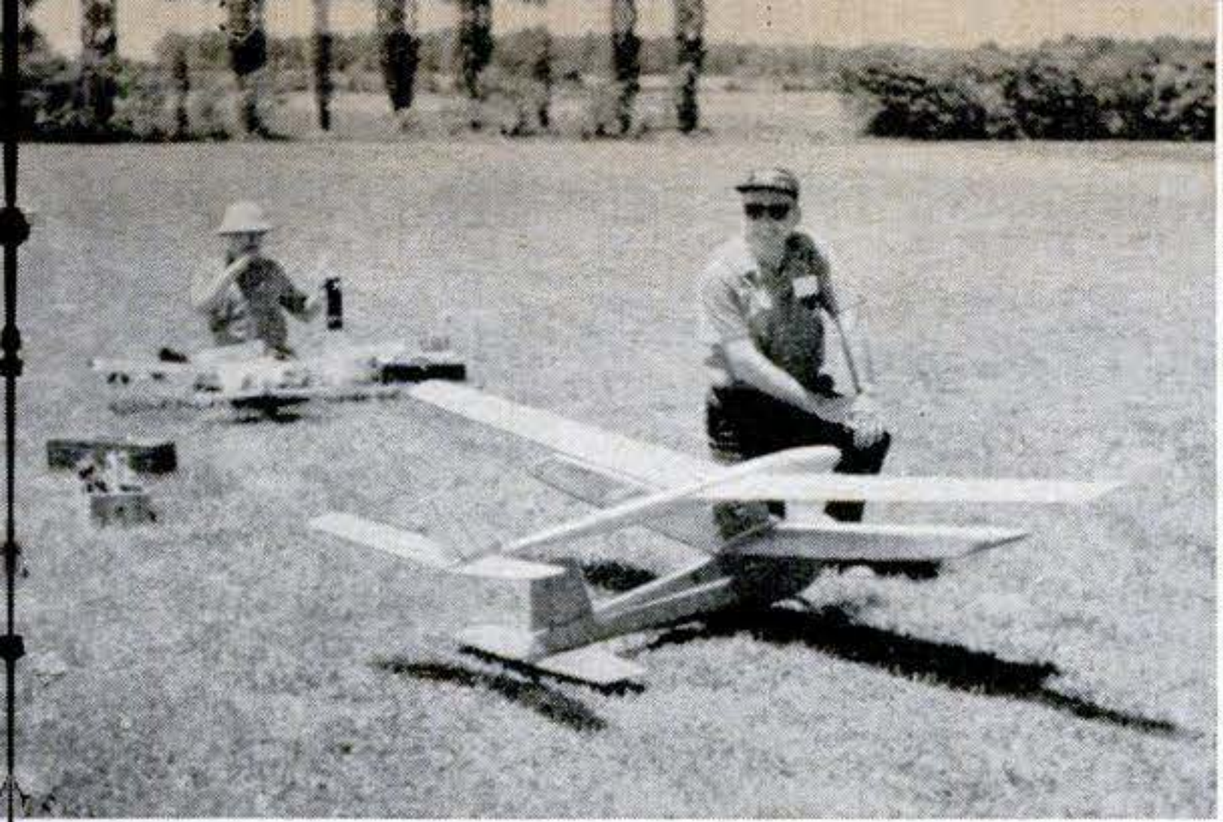

Piggy-back launching uses a power plane to fly the glider on top of it up to soaring altitude.

A small engine atop the glider's wing powers it upwards for several minutes before running out of gas.

contests, touch-and-go events, endurance races, and maximum time in the air are all growing activities.

Records set in glider competition show what these model aircraft can do. The U.S. holds the altitude record with 4,988 feet. Czechoslovakia holds the duration record of over 15 hours. Russia has the straight-line distance record of 14 miles and the closed-course (around pylons) record of 102 miles. West Germany holds the speed record: 78 m.p.h.

Europe's head start shows in the selection of gliders available to U.S. enthusiasts. Many of these are imported from West Germany. American manufacturers are jumping in, however—a growing number of gliders are being made in California. Domestic radio controls are abundant, since gliders use the same kind as model power planes.

What are gliders like? The average glider spans six to nine feet and weighs three to four-and-a-half pounds. Most have only rudders and elevators, though a few have ailerons, and still fewer have wing spoilers to reduce landing speed.

Gliders are built much like power planes. Balsa wood, the old standby, is commonly used for everything but the wing spars, which are often spruce because glider wings must be much thinner. Fiberglass and molded plastic are also popular—they have a sleek natural finish, and color is a part of the material.

You can buy gliders in the same stages of completion as power planes: ready-to-fly, almost-ready-to-fly (ARF), and kit.

What it costs. You can put a glider into the air and keep it soaring for about half what it costs to own a power plane. Glider airframes, even in kit form, aren't as inexpensive as you'd expect from their simplicity. Production is still relatively low. But you need no engine, which is at least half the cost of a power plane. And your radio-control gear can guide a glider with only two channels and two servos instead of four or five. Operating cost is nil: no fuel, no broken propellers to replace.

A first-class outfit should cost about $300. One beautiful molded-fiberglass glider with a 12-foot wingspan, for example, sells for $175 plus shipping from its manufacturer in California. A two-channel transmitter and receiver, two servos, and batteries add another $125 to $150. Both glider and radio-control gear are complete and ready to fly.

By building glider and radio-control equipment from kits, you can get started for less. Power-plane pilots can switch to gliders without buying any radio-control gear. Their present units will operate a glider on just a few of the available channels and servos. Battery drain will be much lower too, permitting either smaller batteries or more current for longer flights.

Whatever the appeal—silent operation, economy, developing new skills, or just enjoying a new kind of fun—glider flying is the fastest-growing branch of model radio control today. PS

For information on model gliders write: *Fliteglas Laminates, 1211 Thompson Ave., Santa Cruz, Calif. 95060; Nelson Model Products, Box 2027, Dublin, Calif. 94566; Polks Modelcraft Hobbies, 314 Fifth Ave., New York, N.Y. 10001; Willoughby Enterprises, 225 W. 1st St., Tustin, Calif. 92680.*

For radio-control gear, write: *Ace Radio Control, Box 301, Higginsville, Mo. 64037; EK Products, 3233 W. Euless Blvd., Hurst, Tex. 76053; Heath Co., Benton Harbor, Mich. 49022; Kraft Systems, 450 W. California St., Vista, Calif. 92083; Micro-Avionics, 530 S. Mountain Ave., Ontario, Calif. 91762; Royal Electronics, 2101 S. Leyden, Denver, Colo. 22204; and World Engines, 8960 Roasash Ave., Cincinnati, Ohio 45236.*

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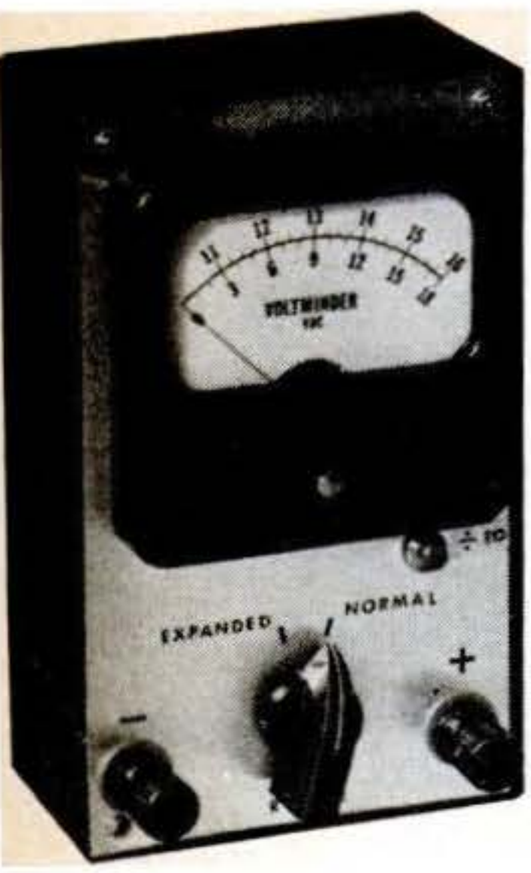


Build a VOLTMINDER

Eight basic tests with this easy-to-make meter analyze or monitor the entire electrical system of your boat or car

By RUDOLF F. GRAF
and GEORGE J. WHALEN

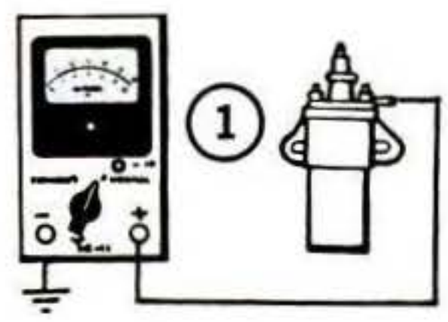
Want to check the circuits of your car's accessories, or monitor the condition of your battery while you're driving? You can with this homemade Voltminder.

The diagrams at right show the simple connections for eight tests (actually, you can do most of them with probe leads). For clarity, the diagrams omit normal system connections. This does not mean that any leads or grounds should be detached for tests, except where specified. Corresponding numbers on the large drawing of a typical electrical system show how these tests cover every aspect of a 12-volt system. Since most of the tests check several components, there's considerable overlap, but this is ideal for isolating your problem. If you get a poor meter reading in all tests involving a given component, you know exactly where your trouble lies.

The Voltminder is built around a standard 0-to-1 milliammeter, modified for dual-scale readings. It's housed in a 2"-by-3¾"-by-6" plastic case, with the metal cover cut out for the meter.

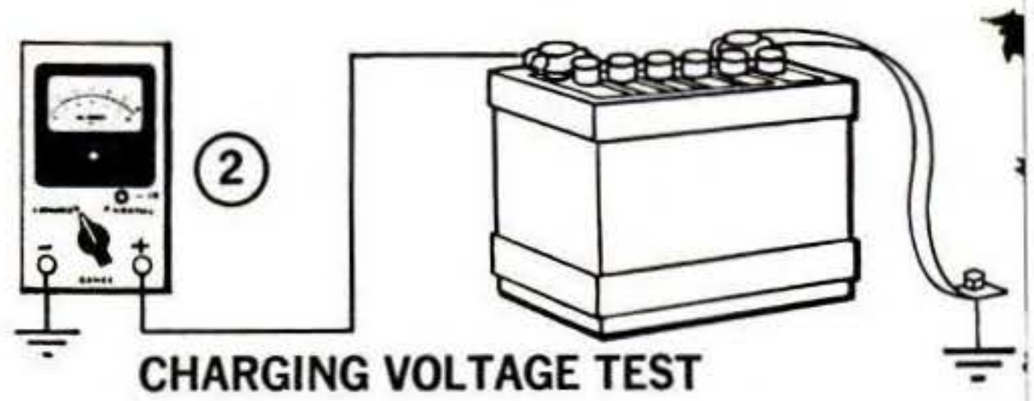
Performing test one. Connect the Voltminder's leads (+) and (−) to the ignition-coil primary and to ground. Set the switch to normal range and disconnect the lead from the high-voltage tower of the ignition coil so the engine can't start. With the ignition on, crank the engine for three seconds. Read the meter; cranking voltage shouldn't be under 9.5.

If the dial shows that or above, all components marked "1" are operating satisfactorily. If the meter reads *less*, you've



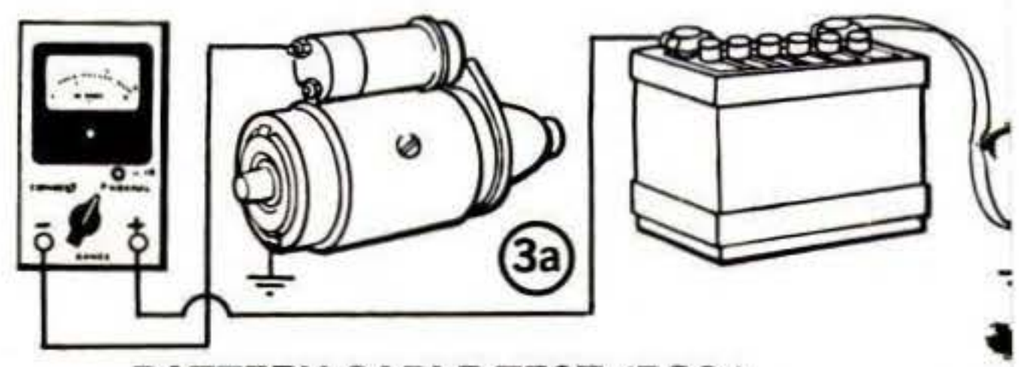
CRANKING VOLTAGE TEST

Is sufficient voltage be delivered to ignition s tem while engine is cra ing? Normal reading c firms condition of batte cables, starting syste current to ignition syste

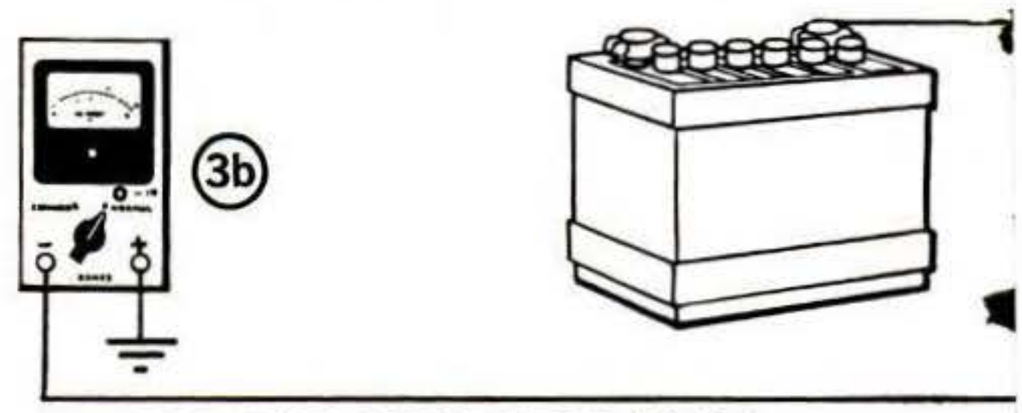


CHARGING VOLTAGE TEST

What voltage is available to entire electrical s tem? This is important factor in cases of distrib tor-point burning and short life of other componen

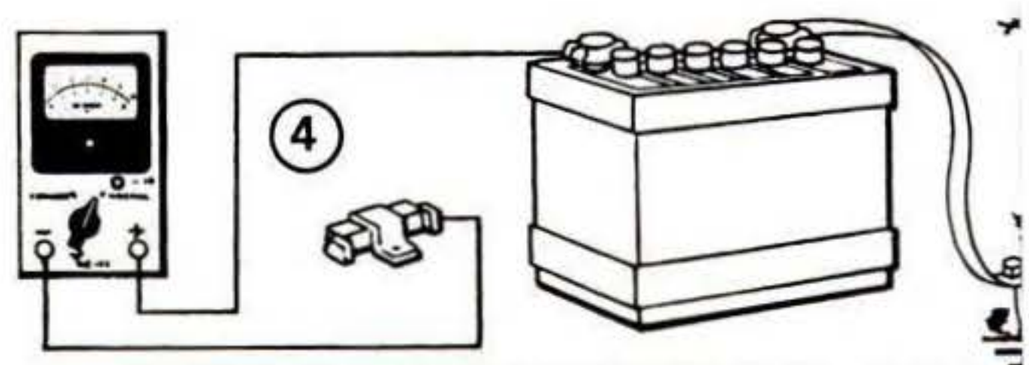


BATTERY CABLE TEST (POS.)



BATTERY CABLE TEST (NEG.)

Are cables defective? undersized? overlong? Are co nections loose or corroded? These faults can caus inefficient starting, improper charging, other ma functions due to voltage drop. Insulated portion cranking circuit may be tested as unit or as inc vidual components. Battery must be fully charge



IGNITION PRIMARY CIRCUIT RES. TEST

Excessive voltage drop between battery and coil ca reduce secondary output of coil, resulting in har starts. This test checks low-voltage ignition wirin

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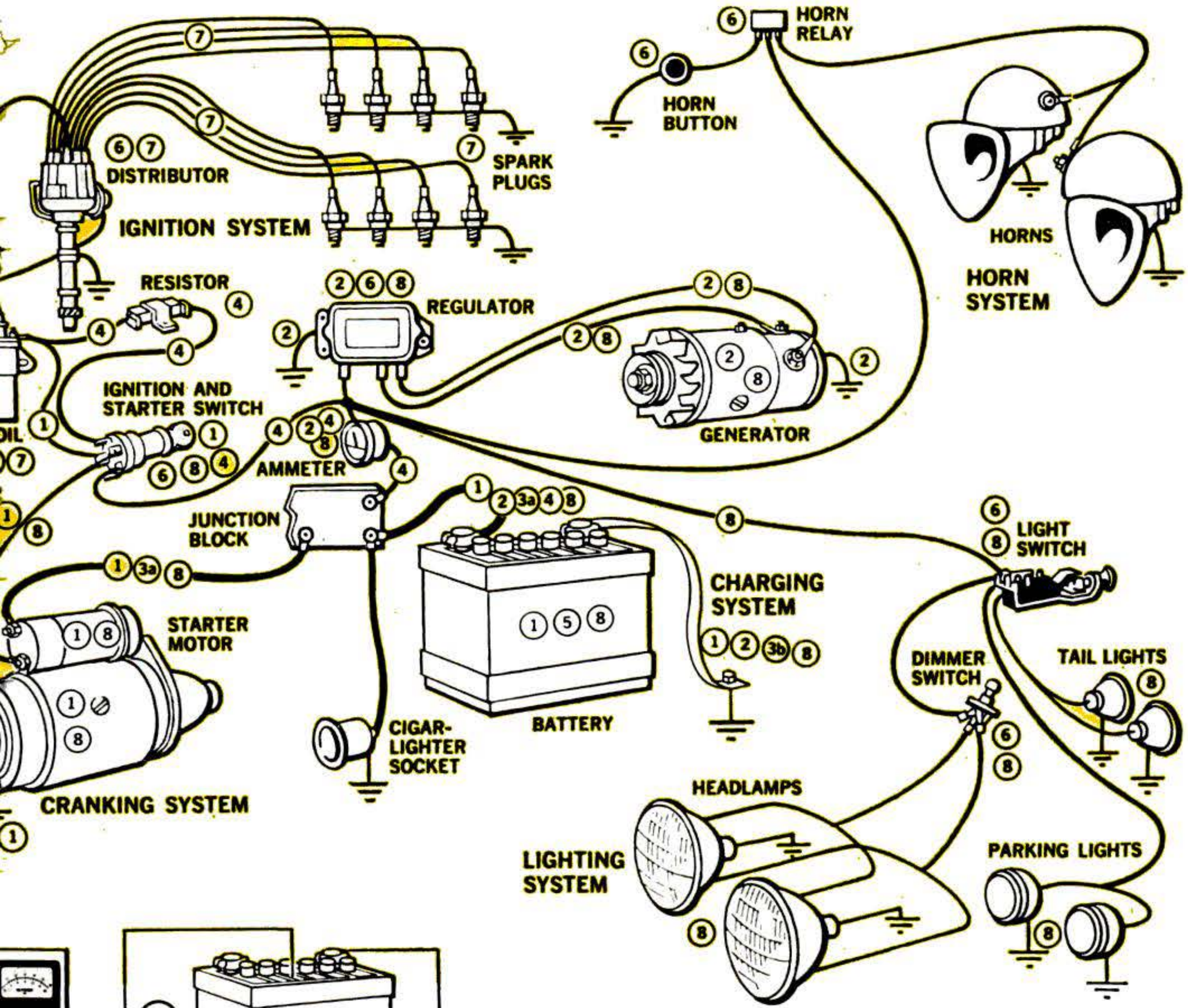
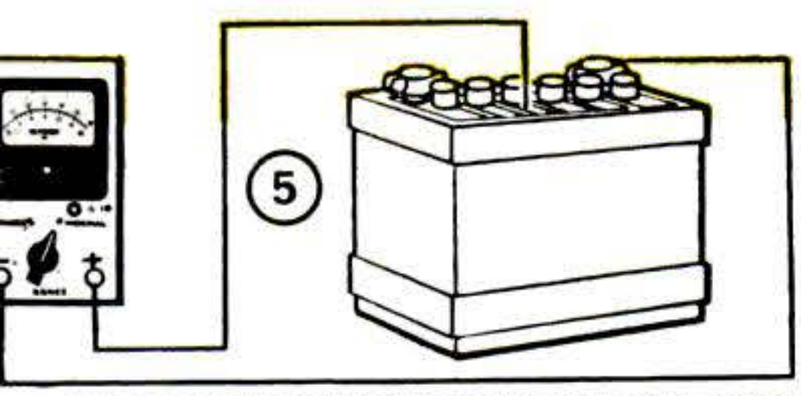
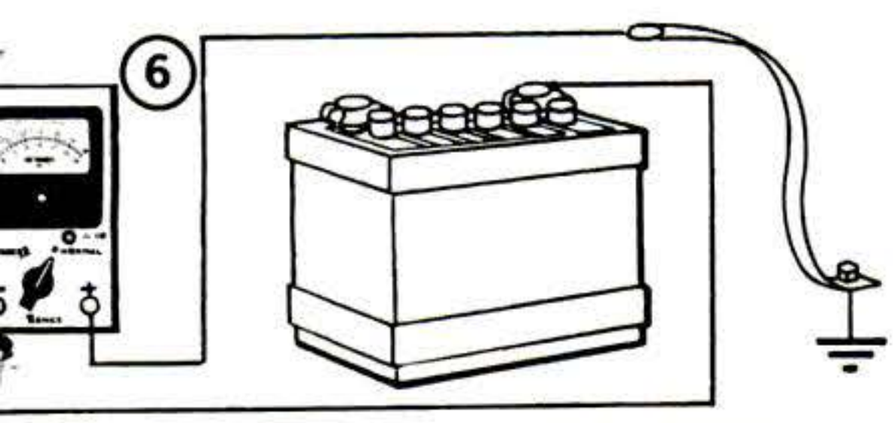
for Your Car





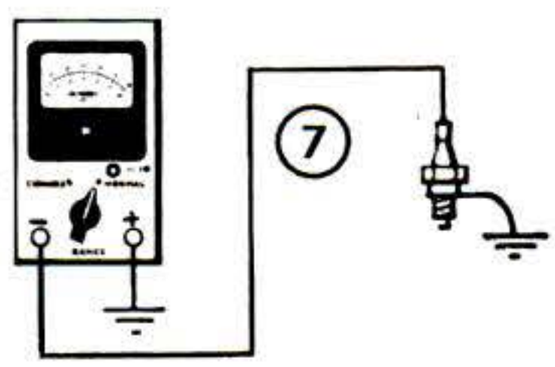
PRIMARY CIRCUIT INSULATION TEST

Defective insulation in primary circuit or at battery can cause constant, gradual energy loss resulting in discharge in damp weather or disuse.



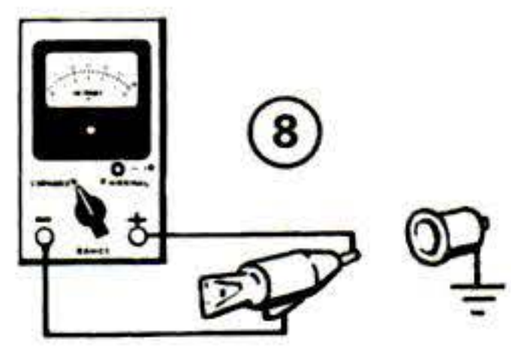
PRIMARY WIRING INSULATION TEST

Leakage in insulation may be too small to be located by an ammeter. With so many accessories on line, leakage may be in one or more circuits.



SECONDARY RES. AND POLARITY TEST

Excess resistance in ignition-coil secondary circuit uses energy needed for good ignition, severely reduces reserve, resulting in poor performance under severe conditions. Incorrect polarity may require up to 40 percent increase in voltage to fire plugs.



TESTS INSIDE THE CAR

To monitor system voltage, plug Voltminder into cigar lighter (adapter used was Workman Electronic's model D18). Set meter to expanded scale, but use normal scale as required. Check battery from front seat as you turn on lights, crank engine, let it idle.

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got a weak battery, defective cables, connections, switch or starter, or a bad bypass or ignition-to-coil circuit. Further tests will show you which.

Test two. Set the switch to expanded range. Observing polarity, connect (+) and (−) leads to the positive battery post (or the battery post of the regulator, if more accessible) and to ground. Run the engine at 1,500 to 2,000 r.p.m. Read the meter after the pointer stops climbing. If it's between 13.5 and 15 volts, your charging system and voltage regulator are operating correctly.

A *lower* reading indicates a defective generator or generator drive, defective or misadjusted voltage regulator, or high resistance in the circuits. A *higher* reading indicates a defective or misadjusted voltage regulator, high resistance in the regulator ground circuit, or a defective field circuit. Further tests will pinpoint which component is at fault.

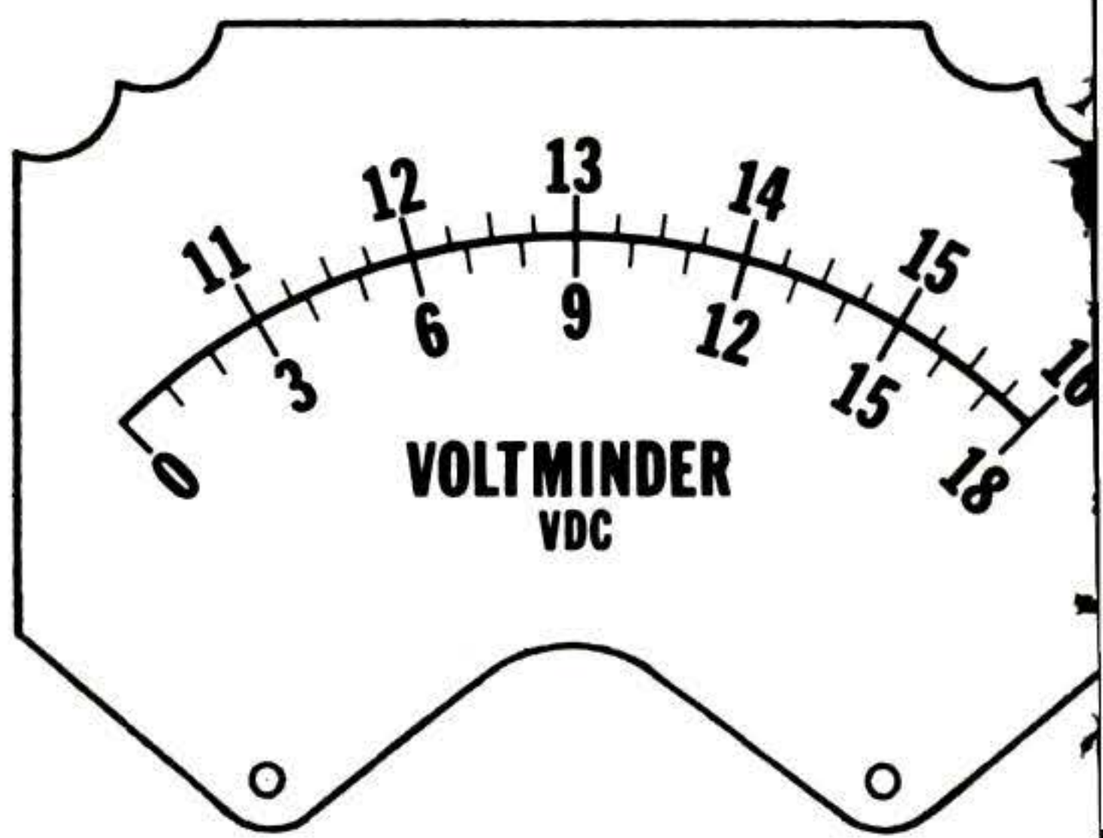
Battery-cable tests. Hookups vary for positive and negative checks. Before making either, if you have any doubts as to whether your battery is fully charged or starter amperage draw is within normal limits, have your mechanic check these components with his battery/starter tester. For both tests, set the Voltminder switch to normal range and depress the ÷10 button *during the test only*.

For the positive test, remove the lead from the ignition-coil tower to prevent engine starting. Connect the (+) lead to the center of the insulated battery post and the (−) lead to the input post of the starting motor. (Meter will attempt to read battery voltage until ignition switch is closed.) Read the meter while operating the starting motor. On most vehicles, it should not exceed 0.5 volt. If in doubt, refer to specs for your car.

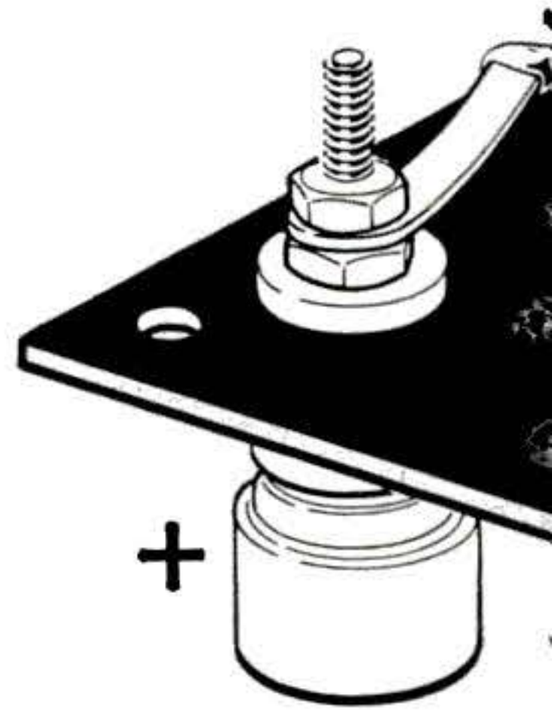
For the negative test, connect the (+) lead to a ground on the engine block; the (−) lead to the center of the battery's negative post. The test is identical to that outlined for positive, above.

If the reading is as specified, cables and connections are okay. A higher reading means a defective or undersized cable, loose or corroded connections, defective starter-solenoid contacts—or a starter that's drawing excessive current.

If you get above-normal voltage-drop



Clip out full-size dial above and cement it ove existing scale on purchased milliammeter. Calibra tions are for DC volts. Note that normal-rang scale, below line, goes up to 18 volts. Top scale i for expanded range—from 11 through 16. Thi yields 3:1 expansion factor for precise readin of voltage levels within the selected range. Tin resistance trimmer controls (R3 and R4 in schematic right) permit individual calibration of two scales



PARTS LIST

D_1—IN961A Zener diode (polarity identification at cathode end); Intnat'l Rect.
R_1—4,700-ohm, ½-w. resistor ±10%
R_2—15,000-ohm, ½-w. resistor ±10%
R_3, R_4, R_5—5,000-ohm miniature trimmer control (linear taper); Mallory MTC53L1
SW_1—SPDT wafer switch; Lafayette 30T4920
SW_2—SPST pushbutton switch
M_1—0-1ma DC milliammeter; Lafayette 99-5040
Misc.—Bakelite case, Lafayette 99-6272; cigar lighter adapter, Lafayette 99-T-8513

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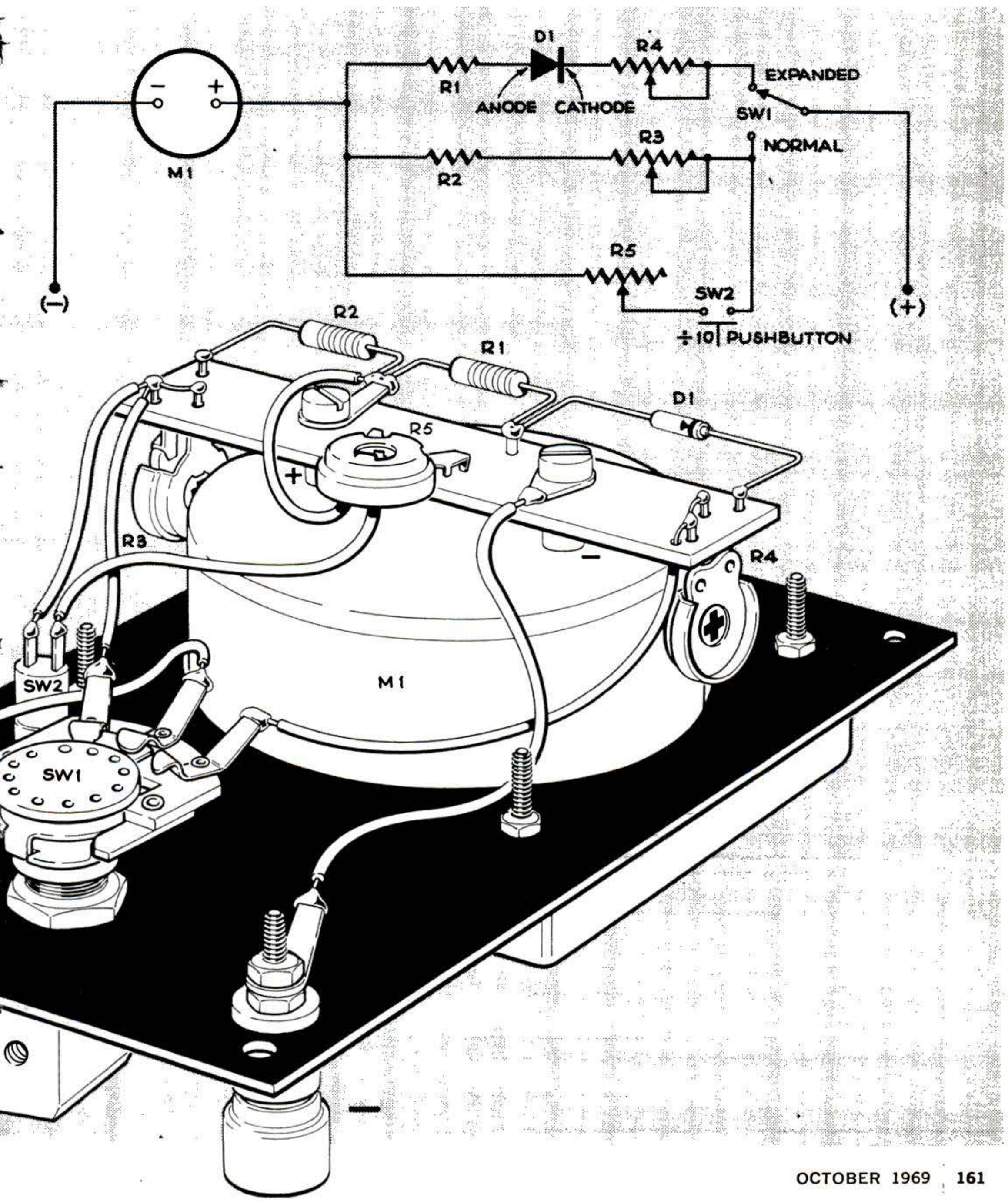
readings, retest each component within that portion of the circuit to isolate the fault. Correct it by cleaning and tightening connections or replacing cables or components, then retest.

Test four. It checks the ignition low-voltage (primary circuit) wiring, including the ballast resistor. (On some cars, a resistance wire is built into the wiring harness to serve the same purpose as a separate ballast resistor unit would do.)

With switch in normal position, connect (+) lead to (+) battery terminal and (−) lead to high side of the resistor (or high side of the coil primary if there's no resistor). Use a jumper lead to ground the primary terminal of the distributor (lead from low end of coil primary). This makes it unnecessary to spot the engine

[Continued on page 212]



ELEGANT DINING:

An Table and

Editor's note: Ken Isaacs is primarily concerned with the design of Living Structures that give you a multiplicity of uses in a limited space.

We introduced him and his Matrix idea to PS readers in March 1968, with an article on his Superchair, followed the next month by one on building other furniture of two-by-twos. Then came the Microdorm (a sleep-study-work unit) in March 1969 and the Way-Out Fun House last July.

The table and chairs above eventually will be commercially produced. An article next month will describe how to build a striking triangular desk you can use with one of the same cube chairs.

You get maximum convenience in minimum space. Use the cubes for other purposes, too

By KEN ISAACS
PS Design Consultant

In developing my Matrix idea, I explored in great depth and detail traditional forms of furniture. As a result, I designed a number of pieces based on past ideas of furniture. These were distinguished by their small scale, and extreme directness and simplicity of construction. The "I" table presented in this article is one of

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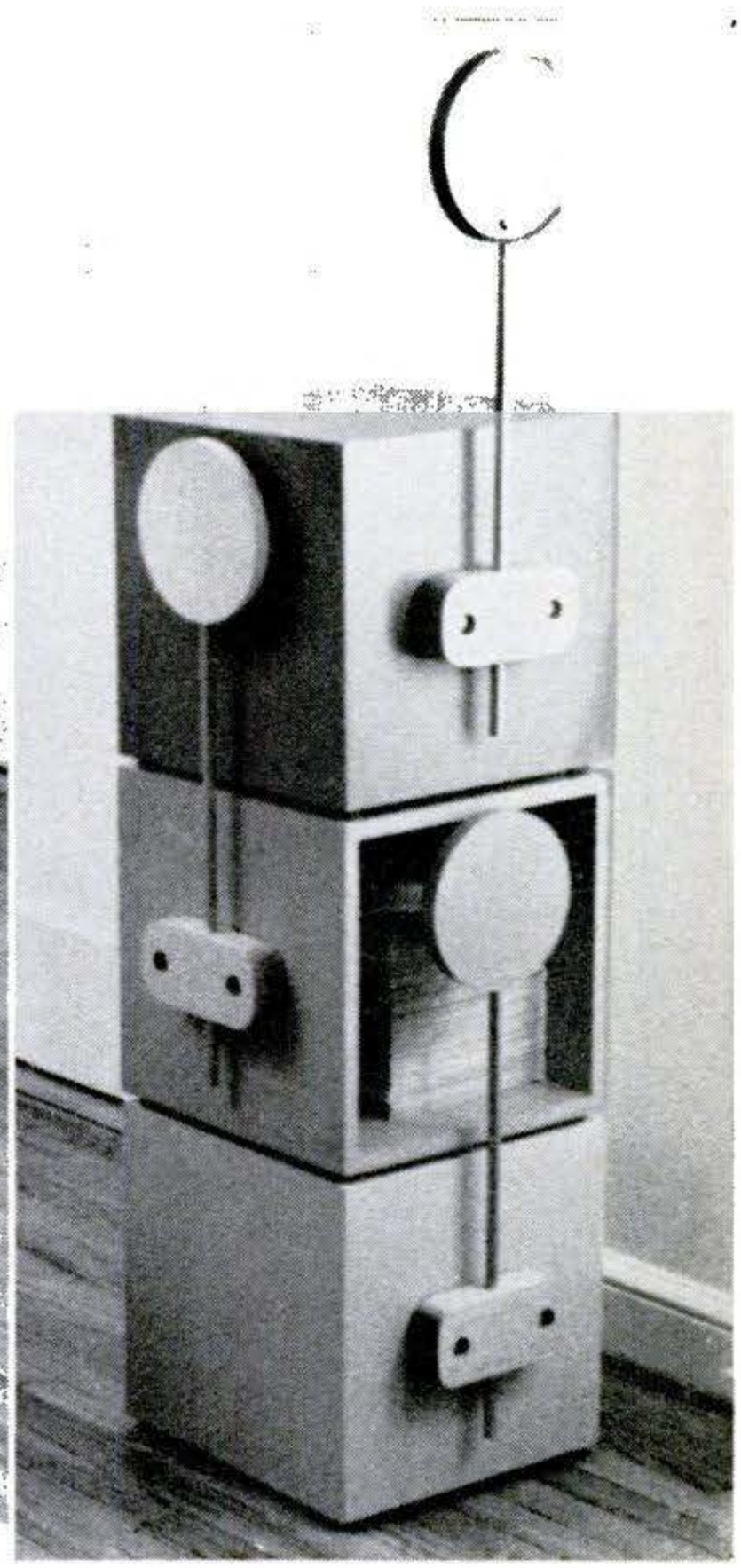

The cube chairs stack as shown at the right, taking a minimum of floor space. Interior can be used for storage of magazines or other items. Table takes its name from resemblance to cross section of letter I.

a Set of Cube Chairs

these designs. It offers the user advantages in an era of shrinking space in housing.

With the leaves down, the table is only 16 inches wide and occupies little space against the wall of a small apartment. With the leaves up, six can eat with elegance. Moreover, telescoping legs allow it to be used at coffee-table height if desired.

The "I" cube was designed as the Matrix chair for both working and eating. The unit is neat and small scale. It offers good storage space for books, magazines, etc. Up to four cubes may be stacked, forming a storage column and taking up little floor space. At the same time, the cubes remain ready to serve as chairs on short notice. The back is resilient and moves in a springy arc when one leans against it, due to the rubber square in the mounting.

Building the table. Pick a straight, dry Douglas fir two-by-six and trim it to 60" in length. If possible, run the top edge through a jointer to insure the top going down at a precise 90-degree angle. Cut two notches for the cross members carefully.

Use maple (or equal-performing wood) for cross member and slides. Dado the groove carefully and then size the slides for the closest possible fit without binding. Remember that the leaf action depends on the accuracy of these pieces. After

Turn the page for lie-flat blueprint

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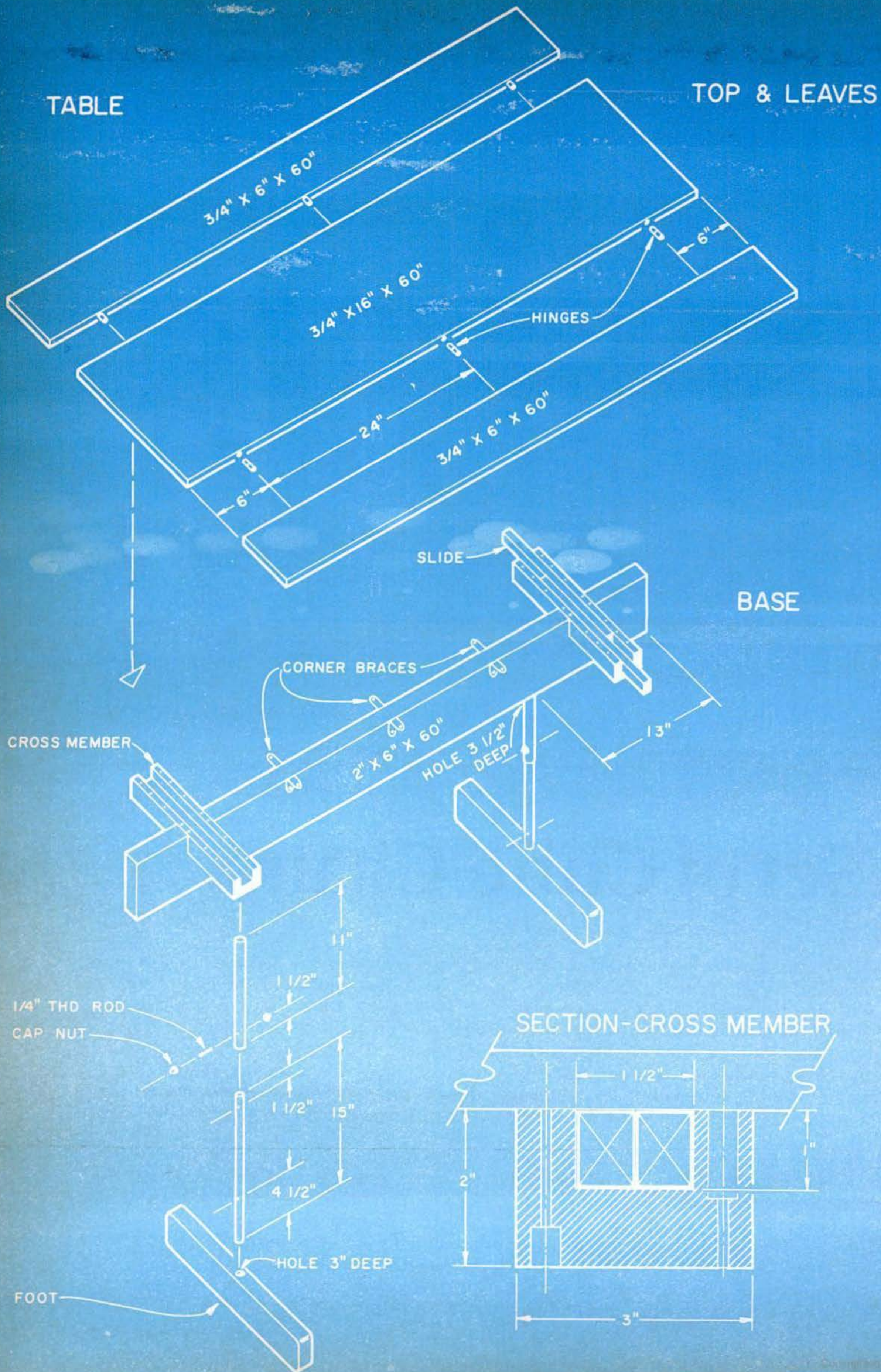
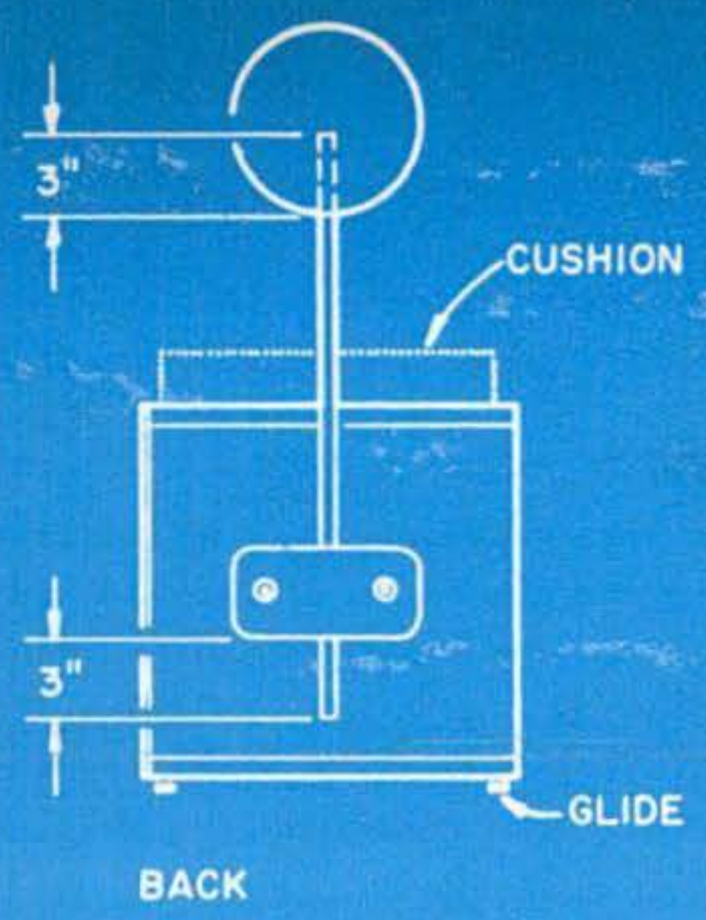


TABLE
TOP & LEAVES
3/4" X 6" X 60"
3/4" X16" X 60"
6"
HINGES
24"
3/4" X 6" X 60"
6"
SLIDE
BASE
CORNER BRACES
CROSS MEMBER
2" X 6" X 60"
HOLE 3 1/2" DEEP
13"
11"
1 1/2"
1/4" THD ROD
CAP NUT
1 1/2"
15"
4 1/2"
HOLE 3" DEEP
FOOT
SECTION-CROSS MEMBER
1 1/2"
2"
3"

PS LIE-FLAT BLUEPRINT

I-TABLE AND CUBE CHAIR



CHAIR

MATERIALS LIST–"I" TABLE

1 ¾" x 16" x 60" plywood
2 ¾" x 6" x 60" plywood
1 2" x 6" x 60" Douglas fir (straight & dry)
2 2" x 4" x 19" Douglas fir (straight & dry)
2 2" x 3" x 15" maple
4 ¾" x 1" x 15½" maple
2 1" OD x 13/16" ID x 11" steel tube
2 13/16" OD x 15" steel tube

HARDWARE

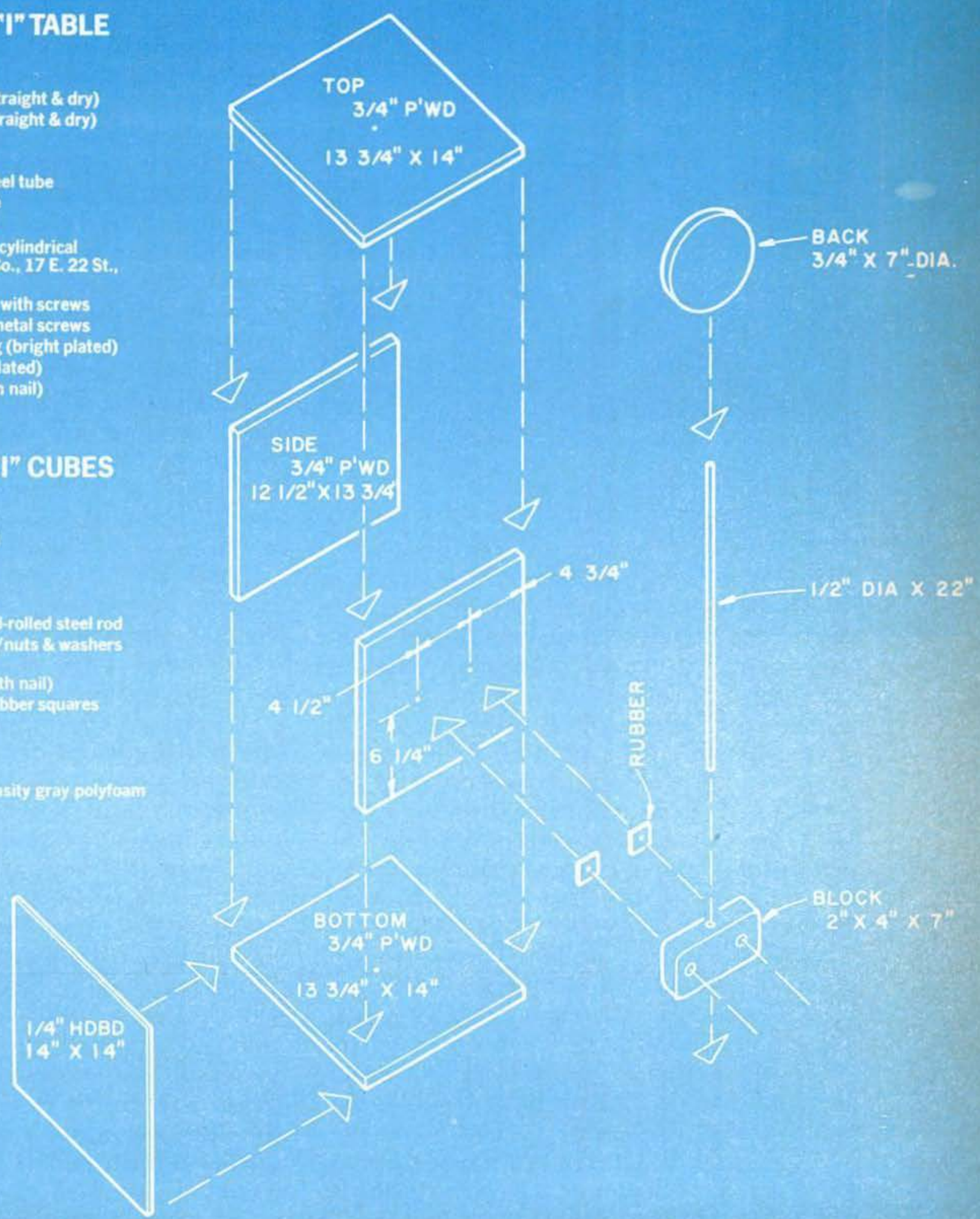
12 14mm x 1-3/16" CHAMP cylindrical hinges (Selby Furniture Hdw Co., 17 E. 22 St., New York, N.Y. 10010)
6 corner braces (formed type) with screws
32 2" #8 binding head sheet-metal screws
2 ¼" threaded rod x 1½" long (bright plated)
4 ¼" x 20 acorn (cap) nuts (plated)
4 steel-and-rubber glides (with nail)
Waterproof glue

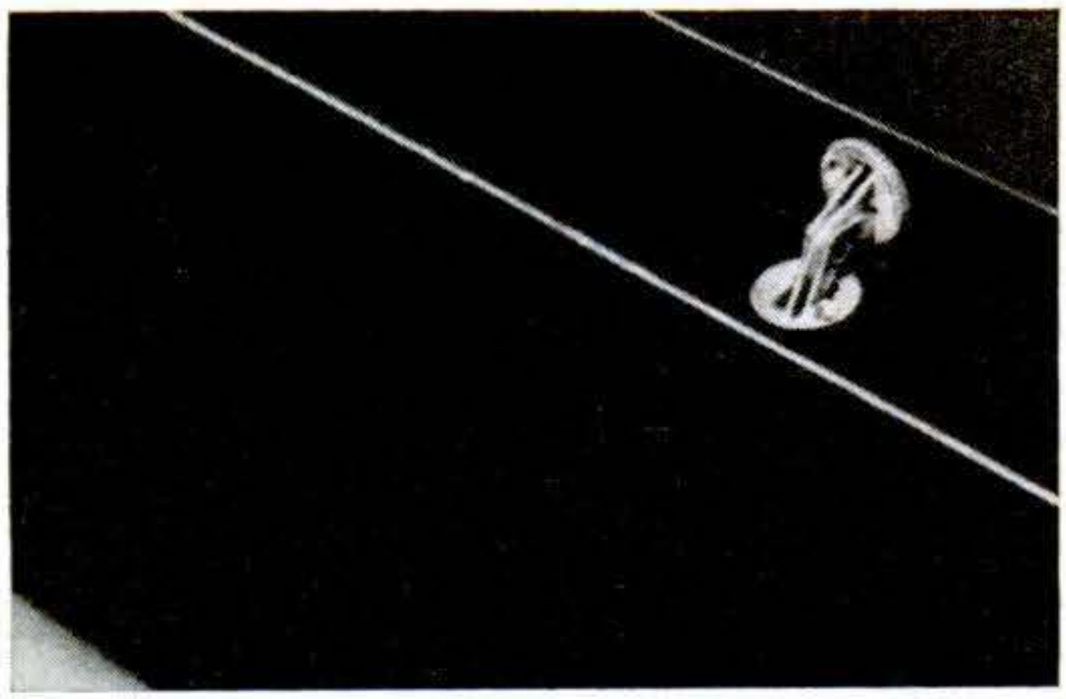
MATERIALS LIST–"I" CUBES

(following for four units)
8 ¾" x 13¾" x 14" plywood
8 ¾" x 12½" x 13¾" plywood
4 ¼" x 14" x 14" hardboard
4 2" x 4" x 7" Douglas fir
4 ¾" x 7" diameter plywood
4 ½" diameter x 22" long cold-rolled steel rod
8 ¼" x 2½" hex-head bolts w/nuts & washers (bright plated)
16 steel-and-rubber glides (with nail)
8 3/16" x 1½" x 1½" black-rubber squares
Finish nails (1¾" long)
Waterproof glue

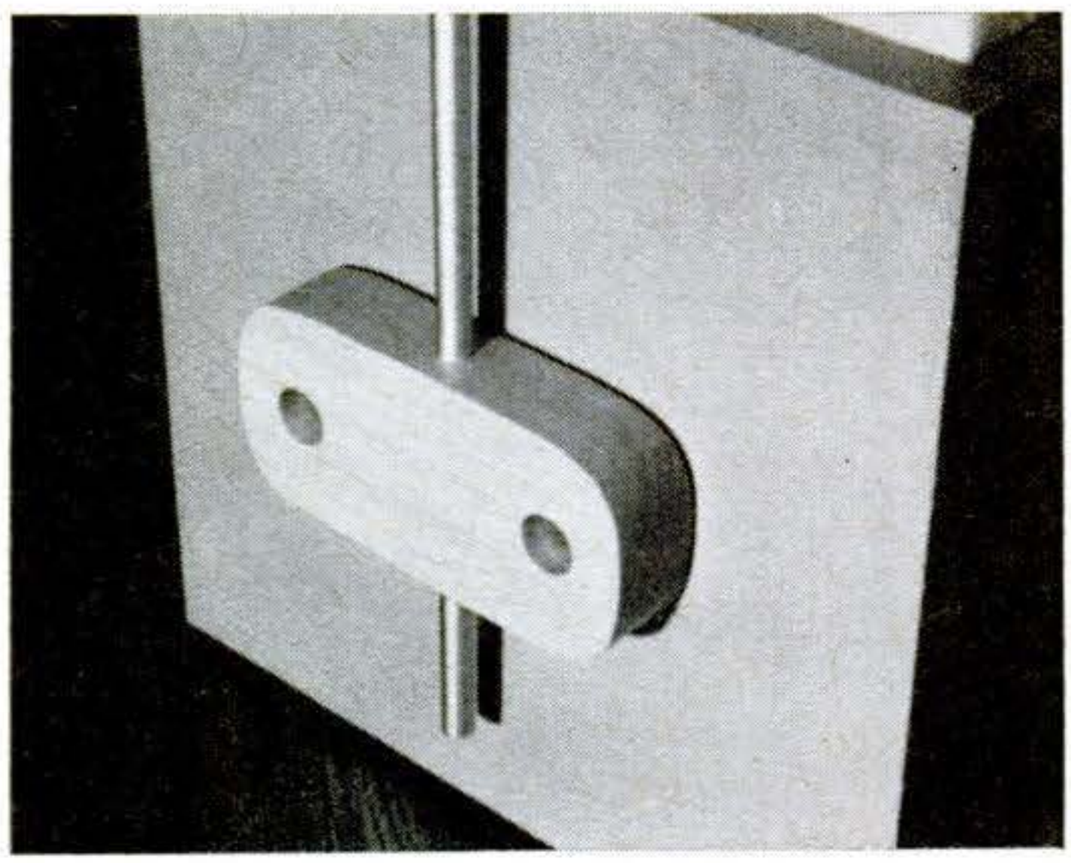
CUSHIONS

4 2" x 12½" x 12½" high-density gray polyfoam





Special cylindrical hinges which you can order by mail from a source in the parts list do neat job on table leaves, but author also suggests you may prefer simpler job of installing back hinges.



Chair back is attached like this. Making the tubing a press fit in the block may be sufficient, but for greater security you may prefer to put a pin through tubing above block. Mount block on rubber pads.

fitting the cross members to the notch in the two-by-six, counterbore four holes in each (as shown in large section on plan) 1⅛″ deep. Use good waterproof glue and 2″ screws to secure.

Shop for tubing for the legs, using the given diameters as a guide. Get pieces with a good close fit. Size and drill ¼″ stop holes. Legs should be bright chrome-plated because paint will not hold up. An automotive plater can probably do this for you along with the ½″ rod for the cube backs.

Cut two pieces of Douglas fir two-by-four to a length of 19″ for the feet. Put a ¾″ radius on the corners as shown in the photographs. Drill a hole to fit the lower leg section of your tubing. A friction fit should work. If you have trouble, you might epoxy this joint.

Drill two holes in the bottom of the two-by-six to fit your upper leg-section tubing. Put off final assembly until finishing is done because force fits are involved for several of the pieces.

Top and leaves are cut from ¾″ plywood (some of the Japanese lumber-core-birch imports are excellent). You will probably want to use plastic laminate on upper surface and edges. Just be sure you apply the proper backing sheet to balance the panel and eliminate warping. The cylindrical hinges are very attractive, but do involve the extra expense of purchasing a drill to install them. Back-flap hinges may be used instead. The top is secured to the cross members by 12 screws through each of the cross members. Holes for these are counterbored exactly ½″. Exercise care to avoid spoiling your top. If the backing sheet will accept glue, use it here. The corner braces supply additional strength when screwed to the top and the two-by-six.

Building the Cubes. Here's your chance to get in the mass-production business. Size all the plywood pieces accurately to insure fine glue joints. You might even want to set up a little quickie jig to help your assembly. Glue and nail the four plywood sides together as shown, taking care with squareness. Cut the fifth hardboard side 1/16″ over 14″ to allow for sanding. Make the two-by-four blocks from Douglas fir with a ⅞″ diameter counterbore ½″ deep. The bolt holes are 5/6″ for the ¼″ bolts.

Drill a ½″ hole vertically for the chrome-plated rod. You can pin these from the back with nails if you like. The 7″-diameter back should be left free to turn, for comfort.

I used polyfoam without covering for the prototypes and recommend it in the dark gray color. The texture of this cushioning material is great and, in my opinion, it makes a fine appearance, but you can cover it if you must.

A spanking white tabletop goes great with the feet and two-by-six in natural fir finished with Firzite and wax. Cubes should be done in bright, saturated colors with rolled enamel. All these combinations are fine with the bright chrome plating of the table legs and back rods. Drill a 5/16″ hole in the exact center of the cube top and bottom for a safety bolt and wing-nut if absolute security is important when chairs are stacked. PS

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Weightlessness is relative: drop ball and container together and ball "floats" above it.

Experiments Simulate Space Travel

By KENNETH M. SWEZEY

By manipulating simple objects, you can learn the principles of escape velocity, artificial gravity, and weightlessness

What do rocket designers mean by "escape velocity?" How does the exact velocity and trajectory of a space vehicle determine whether it will crash into, circle, or race right past its target—the moon, Mars, or Venus? Is "weightlessness" real or an illusion? How can scientists produce artificial gravity?

You can have fun learning the principles behind all these puzzlers by doing a few experiments with home equipment.

Don't laugh at the simplicity of such equipment as the hanging ball above, or the steel ball bearing you roll down an incline, next page. Remember that Galileo deduced his laws of falling bodies by dropping and rolling little balls!

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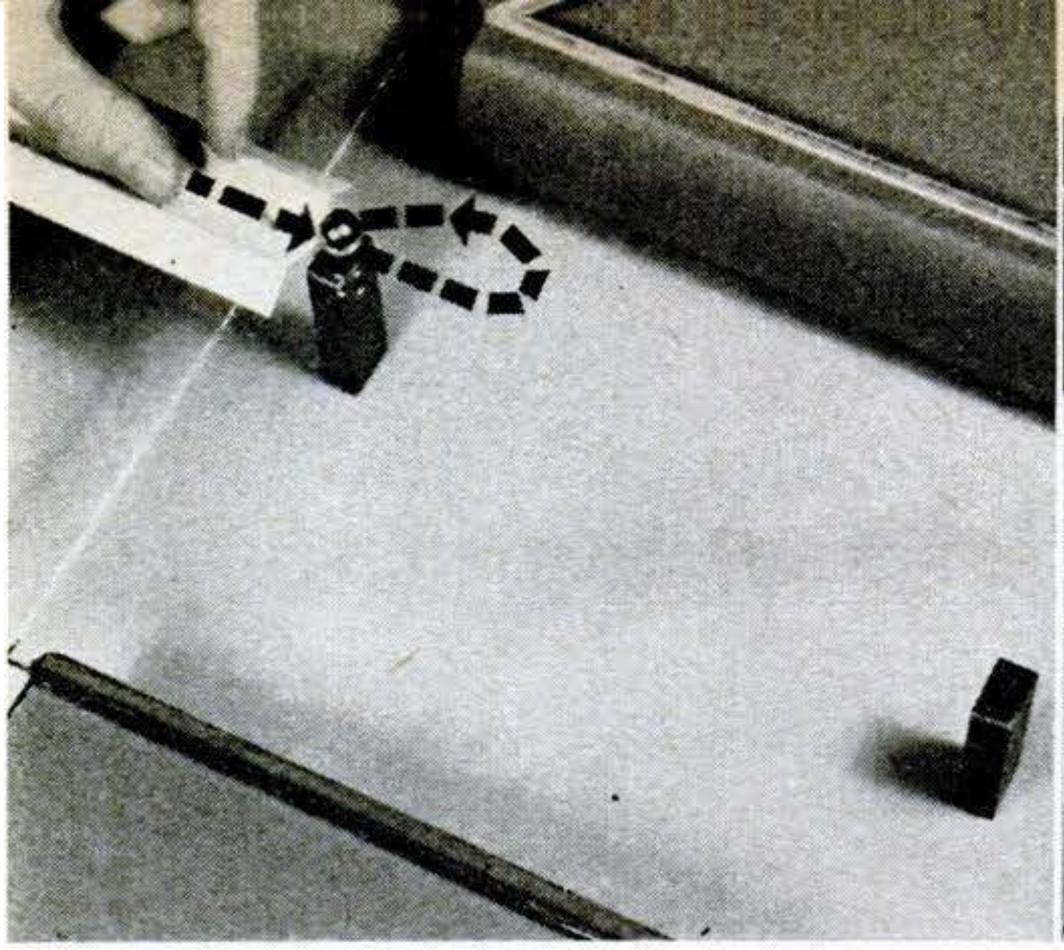

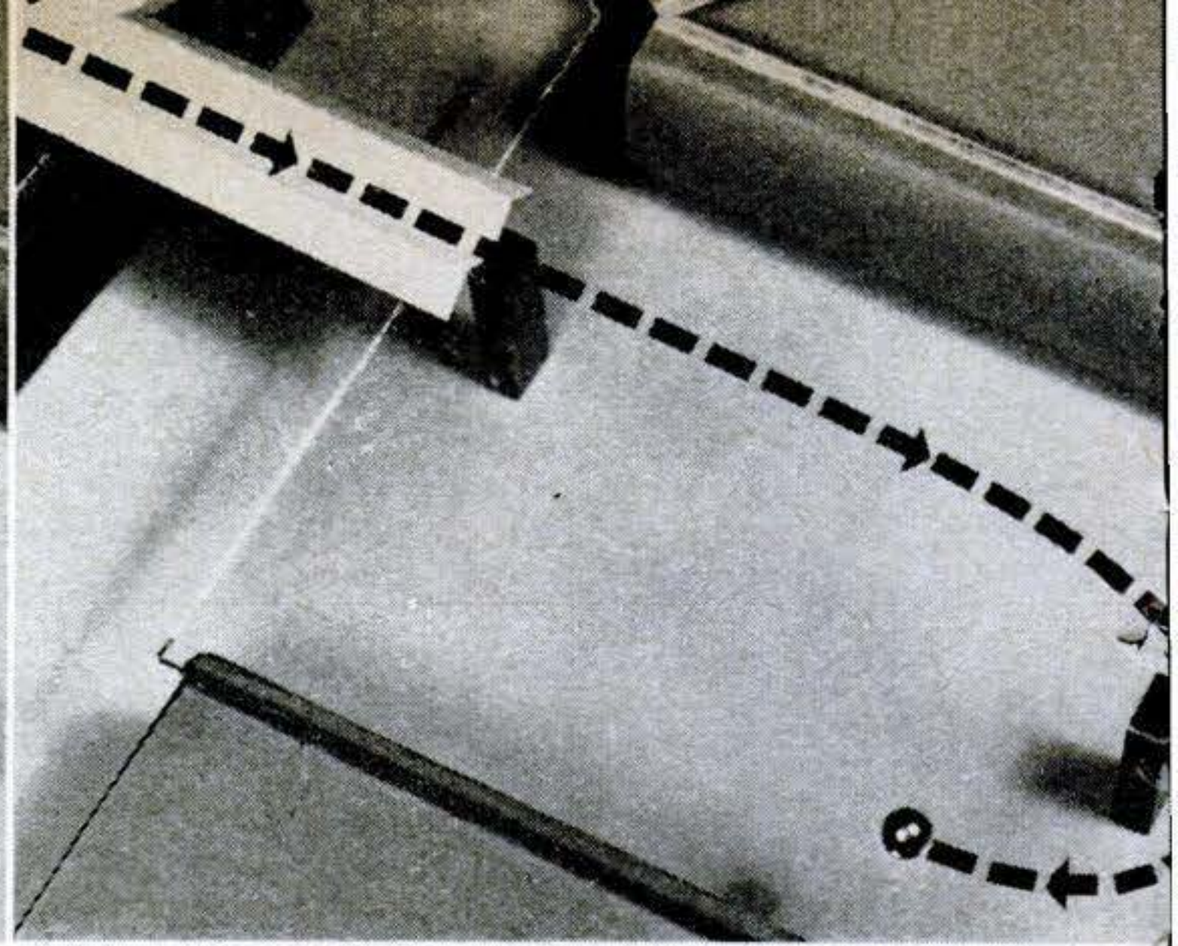

Bar magnet at left represents gravity of earth; one at right, that of moon. Given weak launch onto sheet of glass above magnets, ball-bearing "rocket" returns to "earth" (left). With launch-speed boosted

To simulate a moon shot. All you need is that inclined plane to serve as a booster, a ball bearing for the space vehicle, a sheet of glass for space, and the magnetic fields of two strong bar magnets, set up as in the photos above.

Stand the magnets on end and support the glass just above them on equal stacks of books. Level the glass carefully so the ball can be rolled in any direction without changing course.

For your inclined plane, fold a strip of thin cardboard to form a flattened M. Support one end of this trough on the glass directly over the earth-magnet and the trough's other end on a slightly higher stack of books.

Think of the trough as a multiple-stage rocket that gives velocity to the payload, and the spot where it touches the glass as the burnout point where the last stage stops firing. The more you tilt the trough, and the higher on it the spot at which you release the ball, the greater will be the payload's speed as it starts to coast across "space."

Begin with a slight tilt and release the ball near the low end. The ball will roll out only a short way, then be pulled back to the earth-magnet. Now release the ball higher and higher on the trough until it finally goes fast enough to overcome the magnet's pull and continue over the glass. This is *escape velocity*.

Similarly the escape velocity of a space vehicle from the earth or any celestial body is simply a velocity great enough to get it out of that body's field of attraction faster than it can be pulled back. In the case of the earth, this is about 25,000 miles an hour.

Next, aim the ball toward one side of the moon-magnet and give it enough speed to bring it close. As the ball nears the magnet, it picks up speed—just as the Apollo does as it comes under the gravitational pull of the moon. Depending on its speed and its position relative to the magnet, the ball will head straight toward it, curve past it, orbit around it, or swing back toward the earth-magnet—precisely as a space vehicle would do under comparable conditions.

Weightlessness test. As long as his vehicle is coasting freely (not being pushed by engine thrust or slowed by atmospheric friction) the space traveler experiences weightlessness. In this condition, his body no longer presses against his seat, or his feet against the floor. Objects released from a hand remain poised in the air.

Does this queer condition mean that gravity has been suspended—that the astronaut and the objects around him actually have no weight? Not at all. What happens during weightlessness is that men and objects are all falling freely at exactly the same rate. They *seem* to have no weight simply because there's nothing in their way to check this fall.

To see for yourself, suspend a ball above a plastic container, as shown in a photo. If you release the ball while the container is on a table, it will, of course, drop right in. But what if you suspend ball *and* container as shown, and drop them to the floor together? The ball will drop as fast as before, but the container will fall away from it with equal speed. The ball will therefore hang above the container until the latter hits the floor; a second click tells you that the ball has also hit bottom. Like an object in a freely falling space vehicle, this ball—with nothing to press

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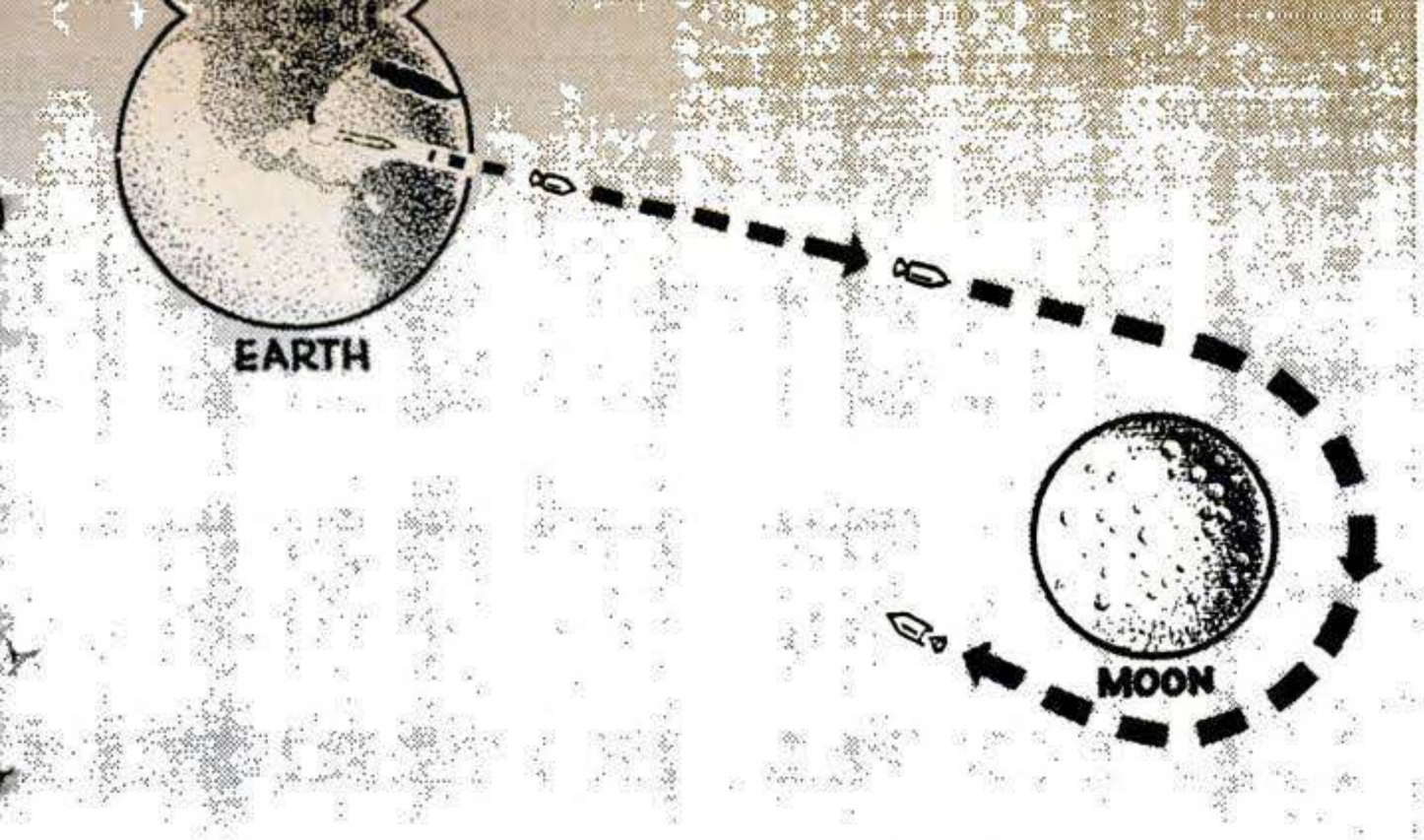


(center), bearing skips out of earth's pull to orbit around far magnet —just as rocket does in sketch above. Try various orbit patterns.

against—would appear to be temporarily weightless.

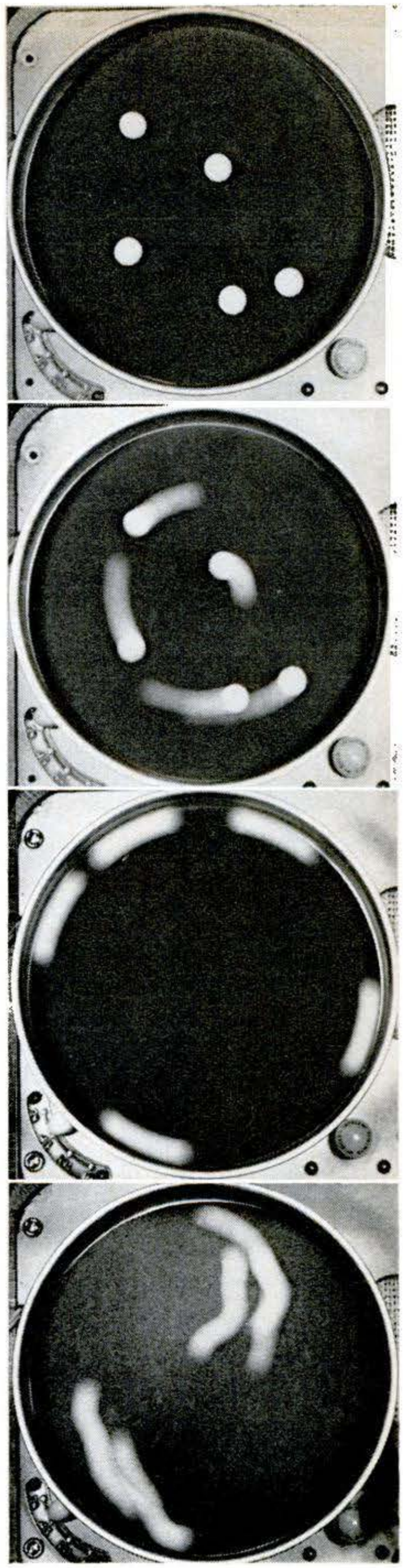
In shorter space flights—such as orbiting the earth for a few days or making a round trip to the moon—the effect of weightlessness is no serious threat to either health or comfort. But for longer trips, it could prove decidedly inconvenient. There would be no "up" or "down." You couldn't walk normally because your feet wouldn't produce traction against anything. Loose tools would float constantly about the cabin. And because warm air wouldn't rise, a sleeping astronaut might even suffocate from his own exhaled breath.

Artificial gravity: This is one way to overcome the difficulties. You merely give the spacecraft a spin to draw objects toward its perimeter. (This is really an effect of inertia, unrelated to gravitational attraction.) In the film *2001: A Space Odyssey*, we saw how a space station in the form of a giant wheel—or the centrifuge section of a big spacecraft—could be whirled at a speed that would cause occupants and furnishings to be pressed against the outer rim with a force exactly matching earth's gravity.

In such cases, the rim of the wheel is always "down." A man can walk, sit, and lie down. Dropped objects will fall, and heated gases will rise. Once brought to the desired speed by a rocket blast, a rotating space wheel would keep spinning indefinitely.

To see how rotation can produce artificial gravity, conduct the experiment shown in the photographs at the right. To raise the cake pan above the turntable spindle, set it on three corks of equal height. Be sure the pan is centered. According to the law of inertia, the marbles, once set in motion, should tend to roll straight ahead. But friction against the bottom of the pan tends to move them in a circle. If the pan turns fast enough, though, the effect of inertia wins and the marbles move forward until stopped by the side of the pan. There they stay, just as men and objects would against the floor of a spinning space station.

Thus three simple tests demonstrate the laws of space physics—and how they can be "repealed" for the greater convenience of man as he ventures even farther from the reassuring familiarities of home. PS



Cake pan on phono turntable demonstrates artificial gravity when you put marbles inside (top photo). Switch on turntable and inertia starts marbles moving toward side of pan (second photo). Once there, they're held by artificial gravity as in spinning space wheel (third photo). Stop turntable and marbles wander aimlessly across pan (bottom) like objects under weightlessness in space.

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Self-contained camping vehicles have full kitchens and baths that can freeze up in cold climates.

WINTERIZE YOUR

Camping vehicles need special attention now if they're to be ready to roll next spring. Here's an experienced camper's advice

By B. F. SAMUELS

It's getting on toward that time when recreational vehicle owners are putting their rigs in mothballs for the winter season so they'll be ready for those weekend jaunts next spring. Trouble is, if you just come in off your last trip of the summer, unload the groceries and leave your rig as she stands, next year's first trip may not be much fun. In fact, you may not be able to get out of your yard.

Whether you use a trailer, camper, or motor home, you should take steps to protect it against whatever combination of dampness, freezing temperatures, rain or snow your climate offers. If you don't, you face corroded or burst water pipes, damaged tires, and a deteriorated exterior, to name a few possible irritations.

The basic problems are the same regardless of what type of rig you have. Of course, it's obvious that a trailer, because of its running gear, will require more care than a camper body, and a motor home with its engine and drive train will demand most attention of all. Likewise, there are big differences within the same type of rig. Plumbing varies from nothing more than a tank, hand pump, and sink to systems equal to the one in your house.

First off, let's assume that you're going to leave your rig in the open all winter. It's best to get it under cover, but few of us can do so. If you leave a couple of windows cracked open a bit to provide air circulation, you avoid that musty smell on the first nice day of spring. At the same time, you don't want rain and snow blowing in. If you can get one side of your rig up against the lee of a building, you may be safe in leaving a couple of windows open on that side.

Another thing that's the same for all rigs is protection of the exterior. At the least, you should give your rig a thorough

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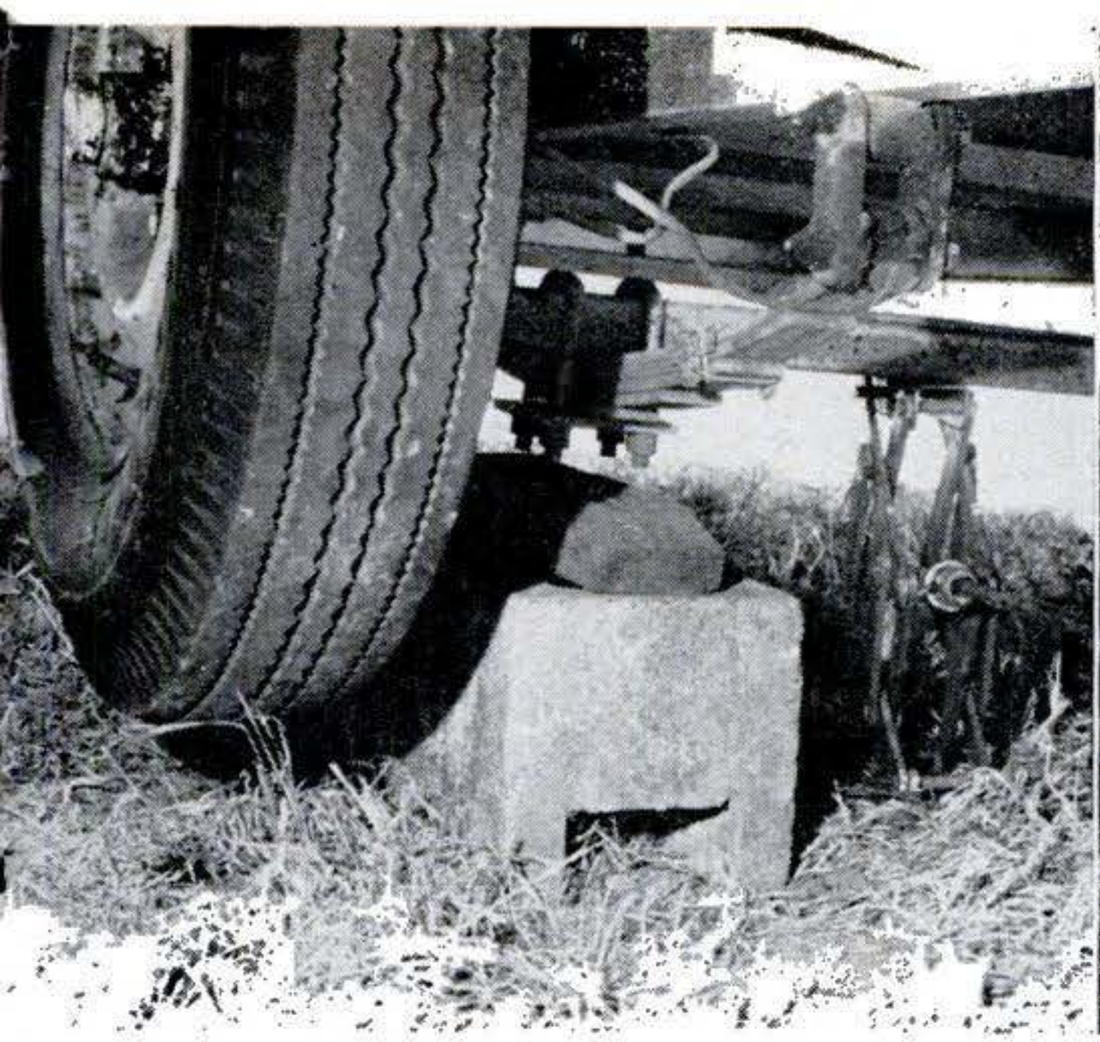
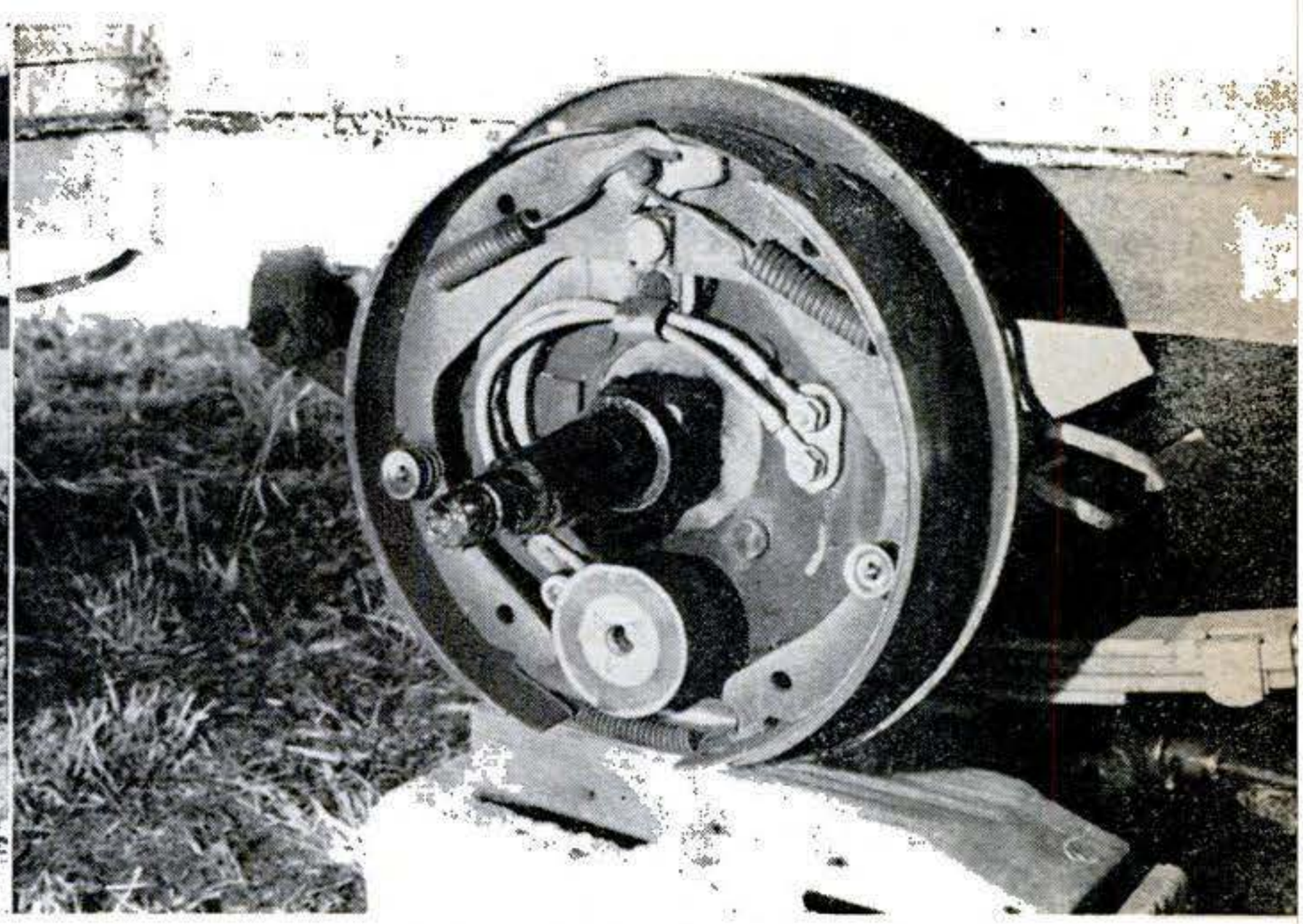


Raise tires off ground to keep them from acquiring permanent set during idle months under load. Jack up one wheel at a time and position supports underneath. For rear wheel shown, spring U-bolts are best point; 2x4 on concrete block protects bolt-ends. Block vehicle with independent front suspension under front A-frames, near where they join the chassis. Mechanic's jacks can be substituted.



Good time to inspect brakes is while wheels are on blocks. Linings on both shoes should be at least 1/32-in. above rivets. Brake above is electric type, gets its primary force from electromagnet at bottom. On such brakes, check magnet. If worn down to screws on its surface, it should be replaced. Since wheel bearing must be removed to get brake drum off, inspect and repack bearing with wheel grease.

HOME ON WHEELS

washing with detergent, followed by a clear-water rinse. For maximum protection, let it dry completely, then give it a wax job with a good carnauba wax. Do this on a warm day, though; many waxes don't really take hold when the metal is below 50-60°F.

In most areas you will have to protect the water system from freezing. There are two ways to do this. One is to expel all the water from it, and the other is to use an antifreeze. Sometimes a combination of these methods is the best thing.

Let's start with the toilet. There are two types in common use; the recirculating toilets are best stored dry. To do this, first drain the unit of contaminated water, then fill it with four gallons of water and one-half cup Vanish bowl cleaner or cold-water detergent. Flush several times to circulate the cleaner, then drain and rinse with fresh water. Remove the pump cartridge as shown in a photo farther on.

If you have a marine-type toilet, both toilet and holding tank will have to be protected from freezing—unless you have one like the Thetford 1400, designed to be freeze-proof. First clean the bowl with Vanish bowl cleaner and rinse thoroughly. (Several toilet manufacturers specify this brand because certain popular cleaners for porcelain bowls will attack the finish on enameled iron.) Disconnect the water inlet and depress the flush pedal fully for

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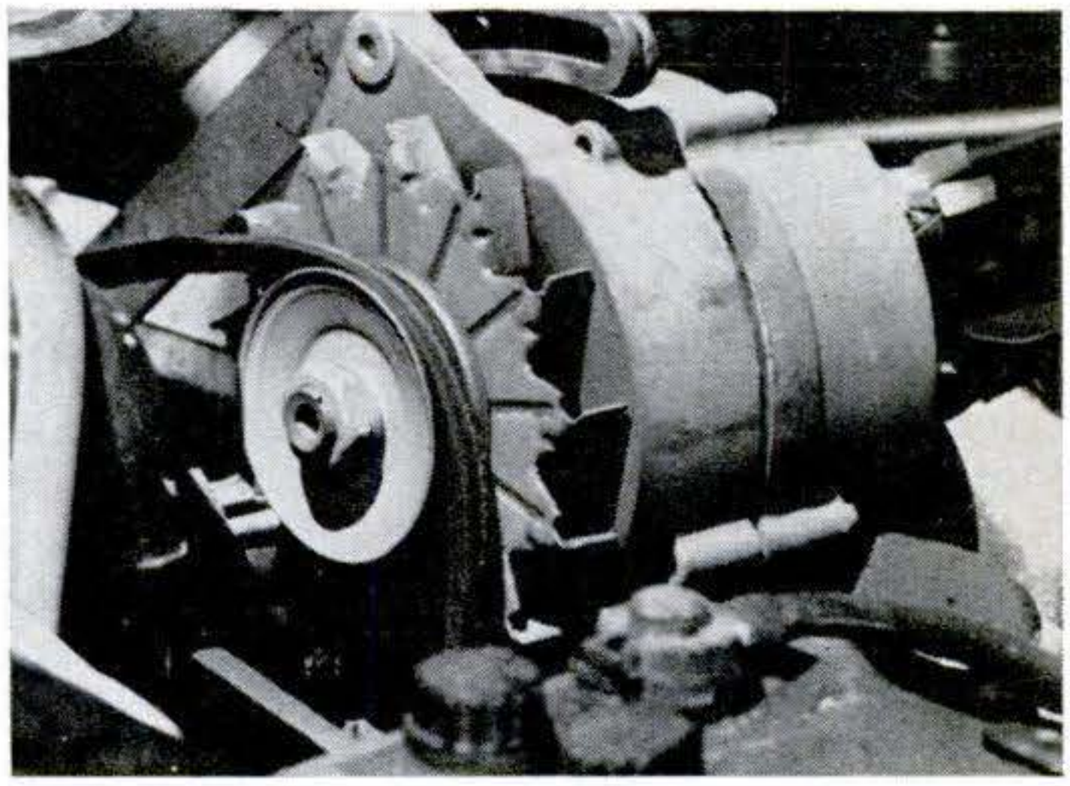

Motor-home engines require extra care for winter layup. Relieve tension on all belts, as here. Alternator has been loosened and swung on its mounting bracket until belt loses tautness. If belts show serious cracking or fraying, remove them and make a note to buy new ones for replacement next spring.

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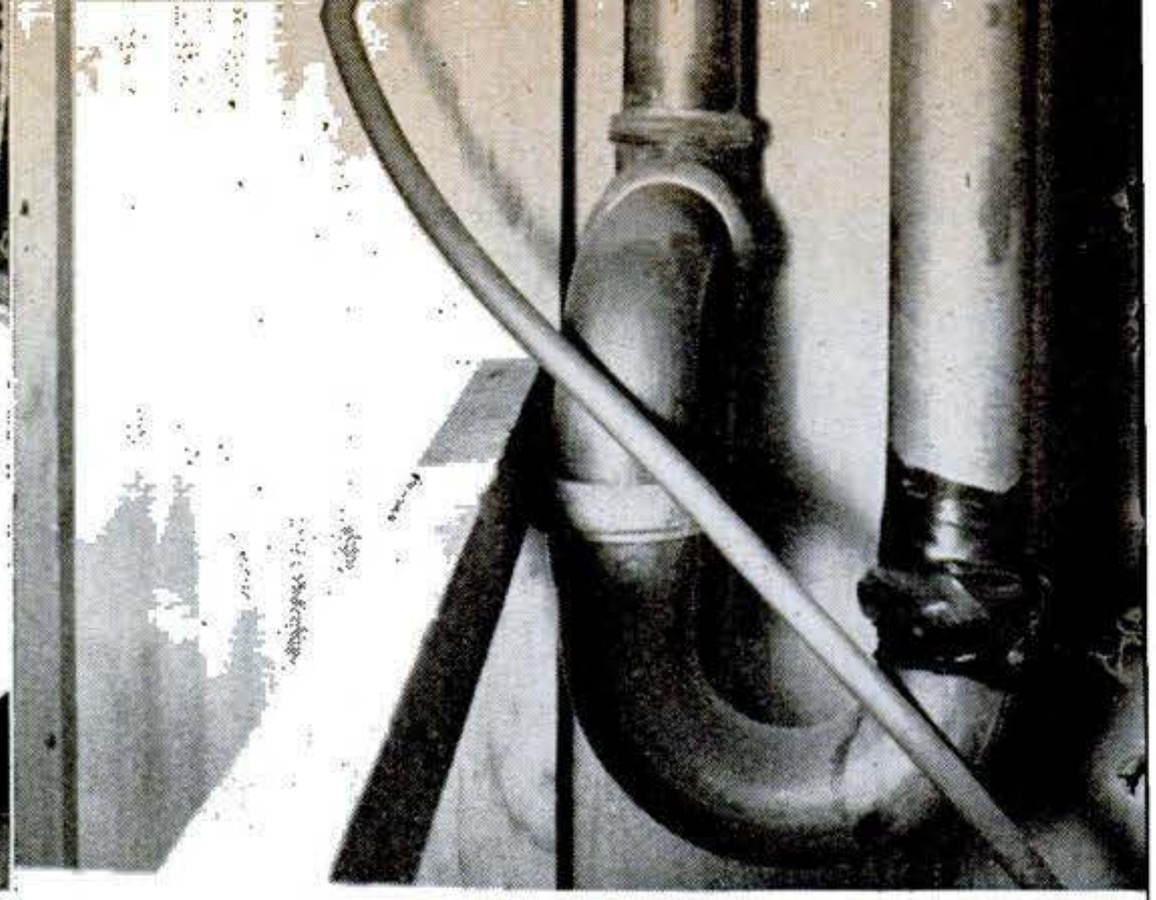
Two water outlets are common on RV sinks—the pump (right) and conventional faucet for external water hookup. Most pumps can be drained by pushing handle to rear as shown, then draining tank. If 10 strokes of handle draw no water, you're empty.



Keep traps from freezing by draining them or filling with antifreeze. Latter is usually easier. In foreground is fresh-water line to sink. Such lines can sometimes be drained, but in complex systems they must be blown out or given antifreeze treatment.

about 30 seconds to drain all water. Drain the inlet line and water-saver hose (if you have one) and drain or blow the water out of the bowl overflow trap.

Cleaners and antifreezes. Your holding tank should be thoroughly flushed out, then laid up with the outlet slide valve open and lubricated. Solid wastes sometimes build up in the tank, especially if you've occasionally let it stand without emptying after a trip. In tough cases you may have to half-fill the tank with water containing one of the cleaners made for this purpose (or a detergent), then make a 35-mile trip over a not-so-good road to shake things loose.

Antifreeze for RV water systems should be either the ethylene glycol (permanent) type, such as Prestone, or a product especially made for recreational vehicles which we'll come to a bit later. Avoid methanol (alcohol) antifreezes. They can evaporate in an open system, and they're deadly poison.

The best way to start winterizing your fresh-water piping is to drain the tank. The next chore is to get the water out of your pipes. Manufacturers tell you to blow the lines out with compressed air, but they're vague about how to do this. Compressed air you can get either from a paint sprayer or at the nearest service station. A sprayer is better because the lower pressure eliminates any danger of bursting joints by zapping the system with too much air at once.

Getting the air into your water lines will require a bit of ingenuity. There are devices made for this purpose, which your local recreational-vehicle dealer may be able to supply. If not, most service stations have a gun-like gadget for the air hose which, when you squeeze its trigger, gives a powerful jet of air through a small nozzle. Of course, if you have a pressurized system that works off compressed air, you can use your own air compressor to blow the lines.

If your system uses a diaphragm pump, disconnect it at the outlet end and run it until water stops flowing. Then apply air pressure at the pipe connecting to the pump's outlet. This is best done as a two-person job, with one handling the air hose and the other opening faucets. The idea is to open one at a time and let it run until air comes out. *After* removing the air pressure, close the faucet and move on to the next one. This should be done at every water outlet, including the shower.

If there's a water filter, remove its element and drain the water from the bowl. If the element is clean, wrap it in plastic film and save it for next season.

Don't miss these. Water heaters are an almost sure-fire source of trouble if they're not drained. To do this, close the inlet valve (usually located on the back side) and turn the thermostat off. Then unscrew the drain plug at the bottom of the heater and let it drain completely, replacing the plug afterward.

There's another approach to freeze protection, which is to fill the water system with a freeze-proof liquid. In the past, such solutions were either corrosive, poisonous, or too expensive. Only a few weeks ago, however, the Thetford company introduced a new product called Aqua-Thaw, designed to be used as an antifreeze

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in both the waste and fresh-water systems. The idea is to pour a solution of it into the tank, then open each faucet until Aqua-Thaw runs out, as shown by a blue color. By running a little into the drains you can also protect the traps. Varying strengths of solution are used, depending on the lowest temperature you expect to suffer. In the spring you merely drain the tank, fill with fresh water, and run the faucets until the blue disappears. Thetford admits that Aqua-Thaw isn't likely to replace your favorite beverage, but a little won't hurt you.

About the gas. Your gas system also deserves some attention. The tanks should be left full to reduce the chance of moisture condensing in them, and the main gas valve should be closed.

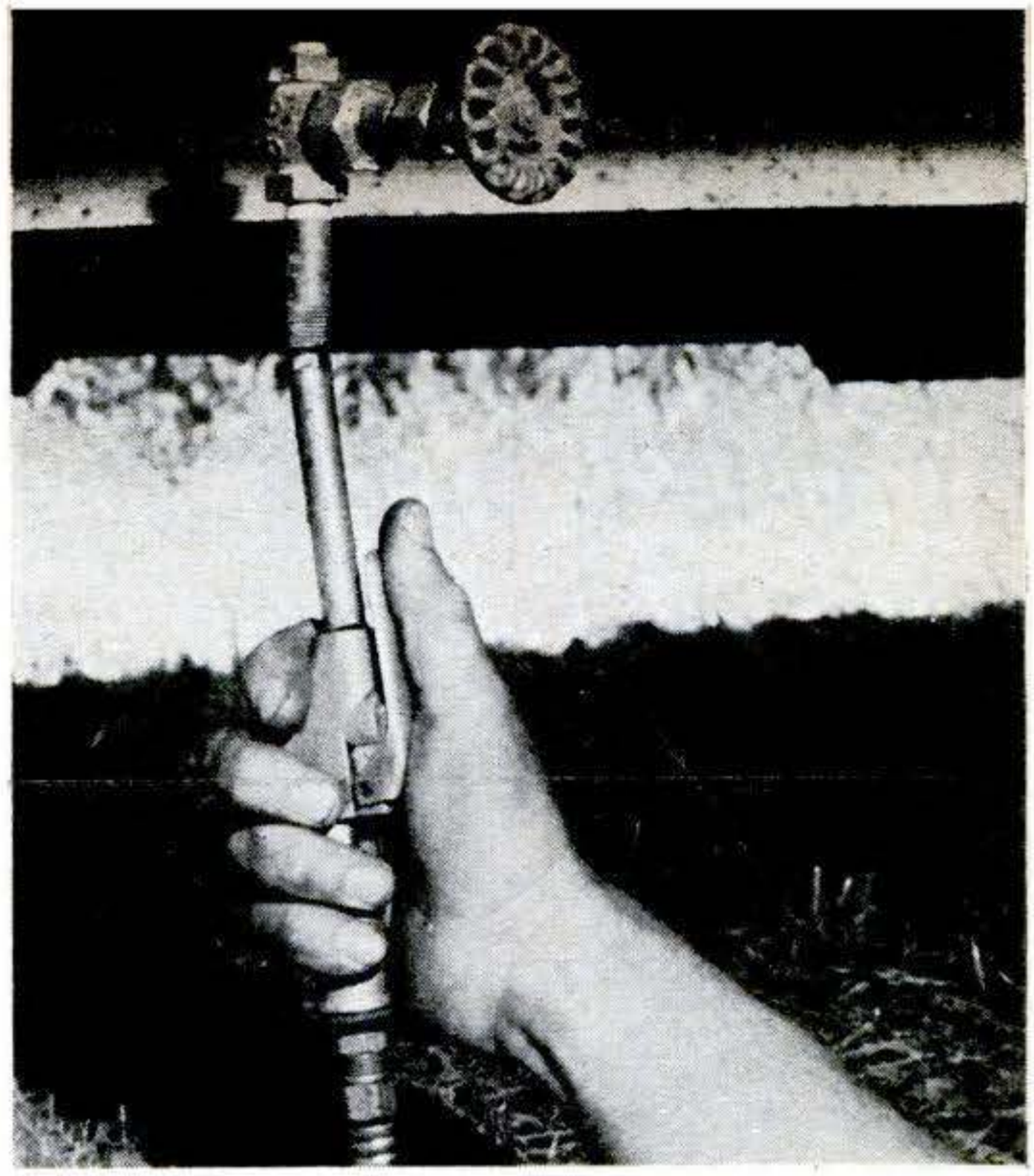
Gas appliances don't need any special attention as far as their fuel systems go, but this is a good time to give the stove and oven a cleaning; also the inside of the refrigerator, but avoid using abrasive cleaners on it. Baking soda is good for removing food odors without scratching. Be sure to leave the refrigerator (whether gas, electric, or icebox) with its door ajar. This will prevent deterioration of the door gasket.

Whether you should leave any food, clothing, or bedding in the rig depends a lot on the climate. A cool, damp winter may promote mildew in fabrics and rust on cans. In any case, don't invite mice or vermin with food in paper cartons.

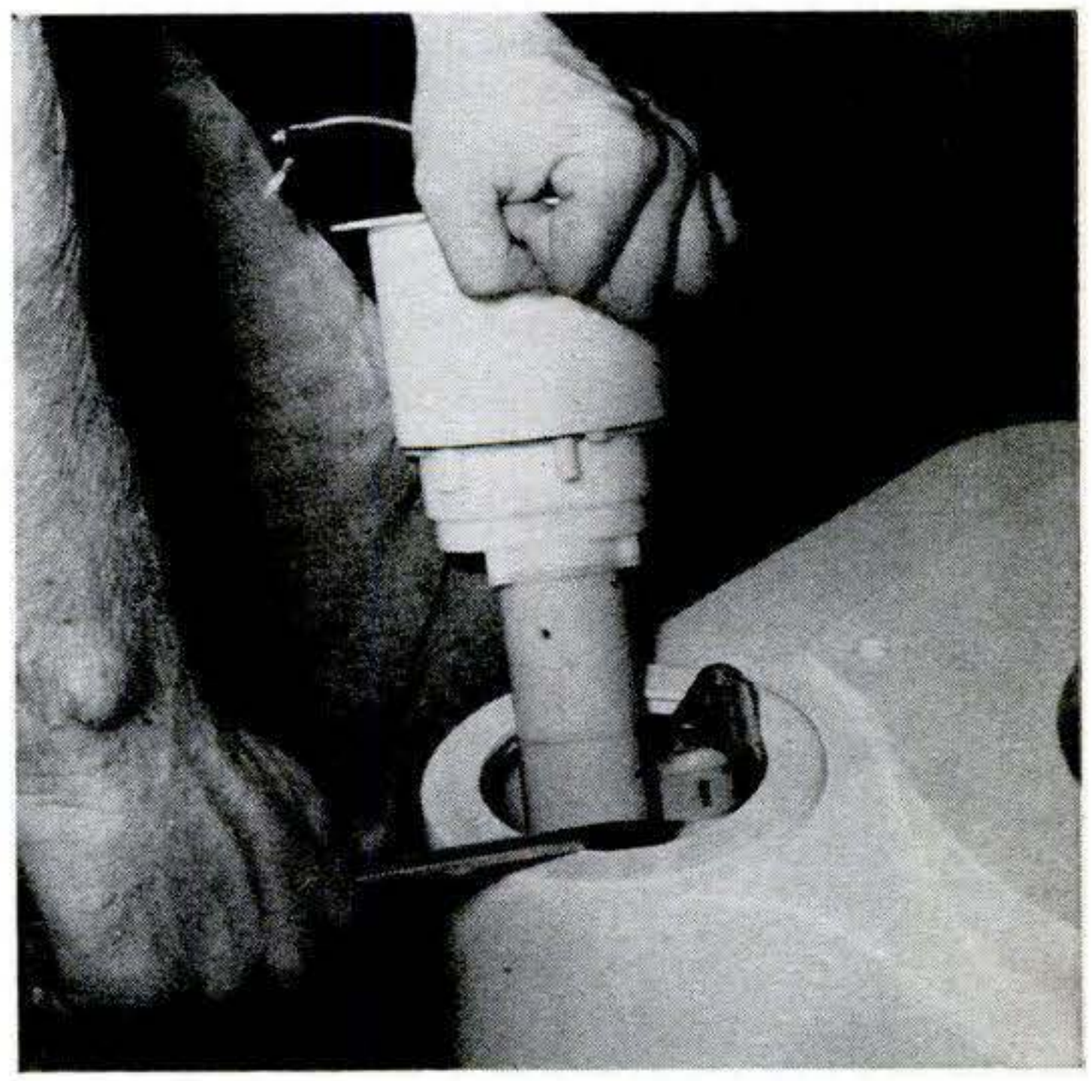
Up until now, procedures have been about the same whether you're winterizing a trailer, camper, or motor home. Now we come to the running gear of your rig, and there'll be certain obvious differences between the three types. The first rule: get the wheels up off the ground.

In extremely cold weather, a battery can freeze if it's in a low state of charge. The ideal procedure is to remove it and store in a cool place, giving it an overnight charge every month. If you're sure it's fully charged, it can be disconnected and left in place.

Grease these surfaces. Trailers should have a film of grease applied to the inside of the hitch socket to prevent rust. The same goes for the hitch ball and, if you have an equalizing hitch, to the bearing surfaces of the spring bars and the hitch sockets into which they fit. Ball and



To blow out water line, air pressure from a paint-sprayer compressor is here applied at water-tank drain. Many rigs have cap instead of valve shown. Pressure can also be applied at outlet of diaphragm pump. But always have a faucet open, inside the rig.



Remove cartridge from recirculating toilets, such as this Monomatic. After prying off cover, lift cartridge assembly and pry off hose connection. After cleaning cartridge, replace it and store unit dry. In some units, twist-on connectors must be removed.

spring bars should be stored away from the weather. A layer of plastic film over the greased surfaces will prevent them from picking up grit.

Brakes do not require any special attention for winter layup. However, they should be inspected periodically for wear and now's a good time, because if work is

[Continued on page 180]

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Your Guide to Tin Snips

One or two pairs of these metal-cutting tools are a must for almost any home

By R. J. De CRISTOFORO

Should an average home owner buy a pair of metal-cutting snips? Does he have any real need for them? If so, what one particular type should he choose? Should he own several?

When the editors of POPULAR SCIENCE asked me to consider these questions about the class of tools known as tin snips, my first move was to check my own shop. I found these snips on hand:

- A set of left- and right-hand compound-action type, commonly referred to as "aviation snips" because they were developed for use in that industry.
- A 12-inch regular-pattern type, usually called "straight" snips since they are designed primarily for straight cutting.
- A pair of 10-inch duckbill snips. These may correctly be listed as a "combination pattern" since they are made for cutting either straight or curved lines.
- Palm-size light-metal snips that I usually find in my son's room because they are so handy for model building and some electronics jobs.

The oldest of these, I realized with some degree of shock, are left- and right-hand cutters that I bought more than 25 years ago when I did a stint building P-47s. In addition to making me pause and reflect, this fact points up the advisability of buying good tools to begin with, and caring for them. This particular set has never been out for repair.

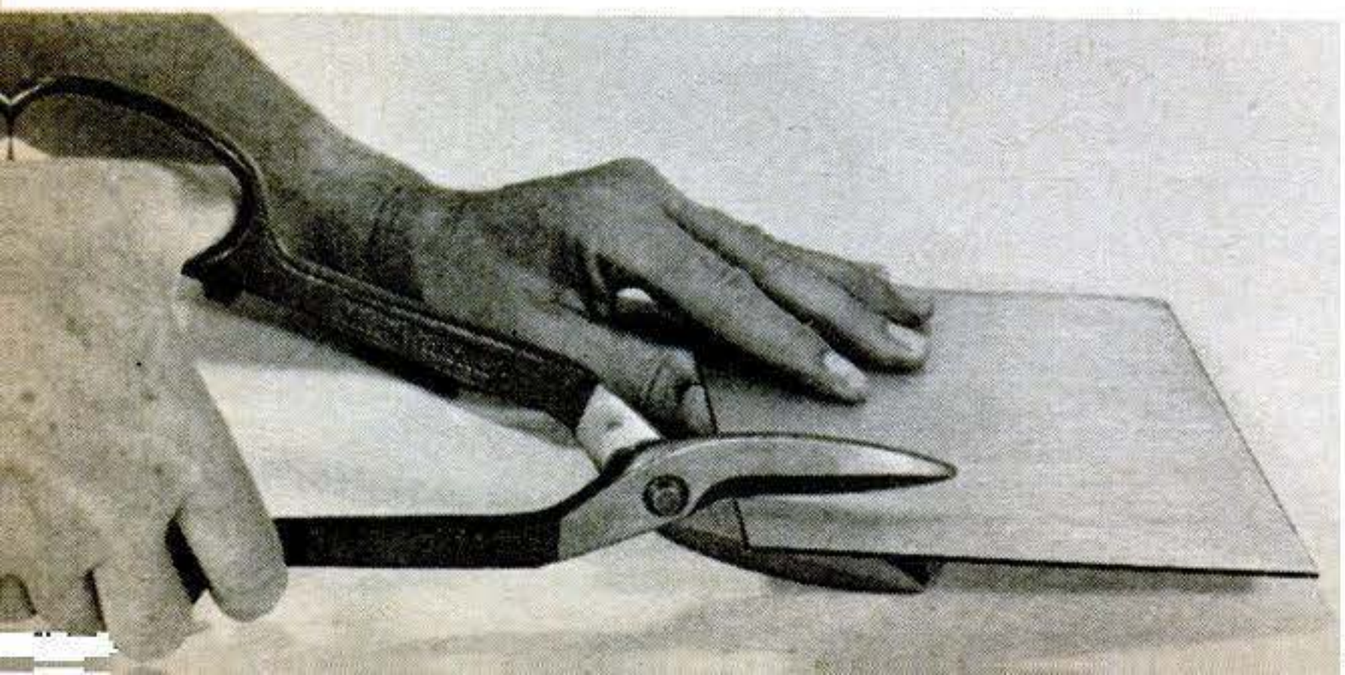
Of the snips on hand, these continue to get the most use, probably because the concept provides a strong cutting action that requires less effort than other designs. Built-in springs open the blades automatically and they are a snap to guide through intricate cuts. Usually, the cutting edges are finely serrated and this serves to grip the metal so you can stay on a line with little trouble. To get the most out of them you should buy both a left- and a right-hand pair.

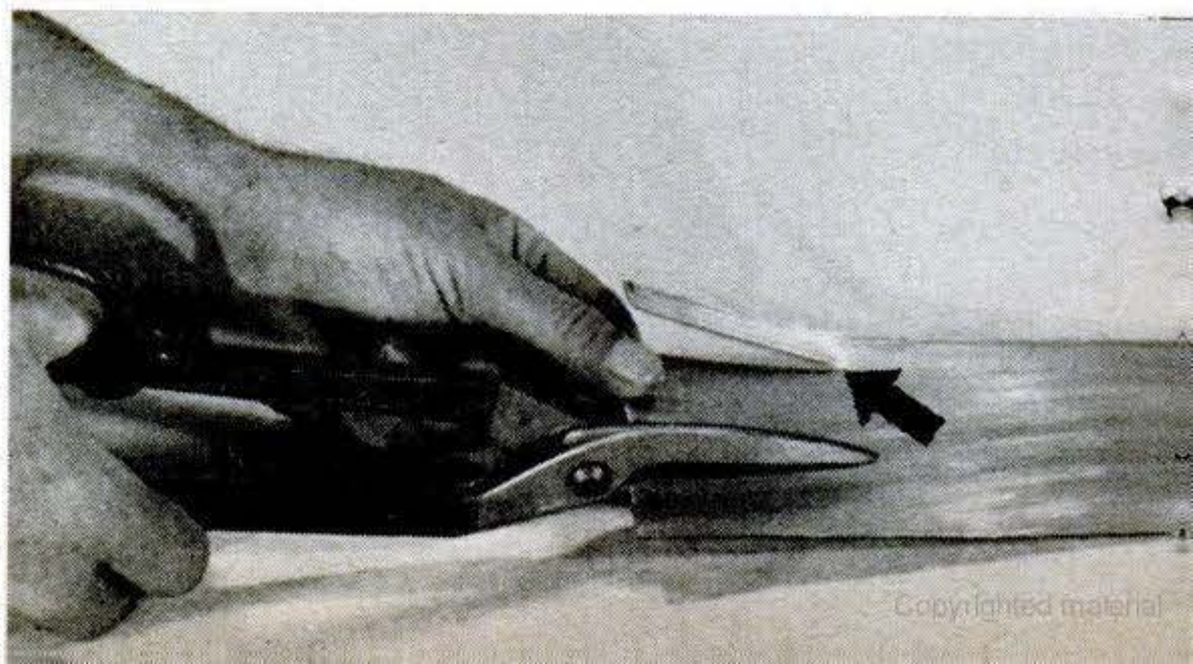
Straight snips. Common types of regular pattern, straight snips range in size from six to 12 inches. Unless you have a specific need for a small size, the 12-inch is a good bet for average home-workshop chores that don't involve working with sheet metal heavier than about 20 gauge. Use these snips mostly for straight cuts even though they can be maneuvered around generous outside curves. The inside faces of the blades are flat. If the snips are held at right angles to the work surface, the inside faces will slide along the cut edge and guide the tool.

If you want something similar but a bit more versatile, choose a combination pattern (not the duckbill) with beveled

Continued

Greatest force you can exert with snips is right at the throat of the blades. That's where you should start cuts. Resting lower handle on bench top is a good idea for heavy work and long cuts; lets you apply more pressure with less finger strain. Don't make full-blade cuts or you'll get imperfections (arrow) at each stop. Smoother, easier cuts result when you limit action to ½ to ¾ blade length.





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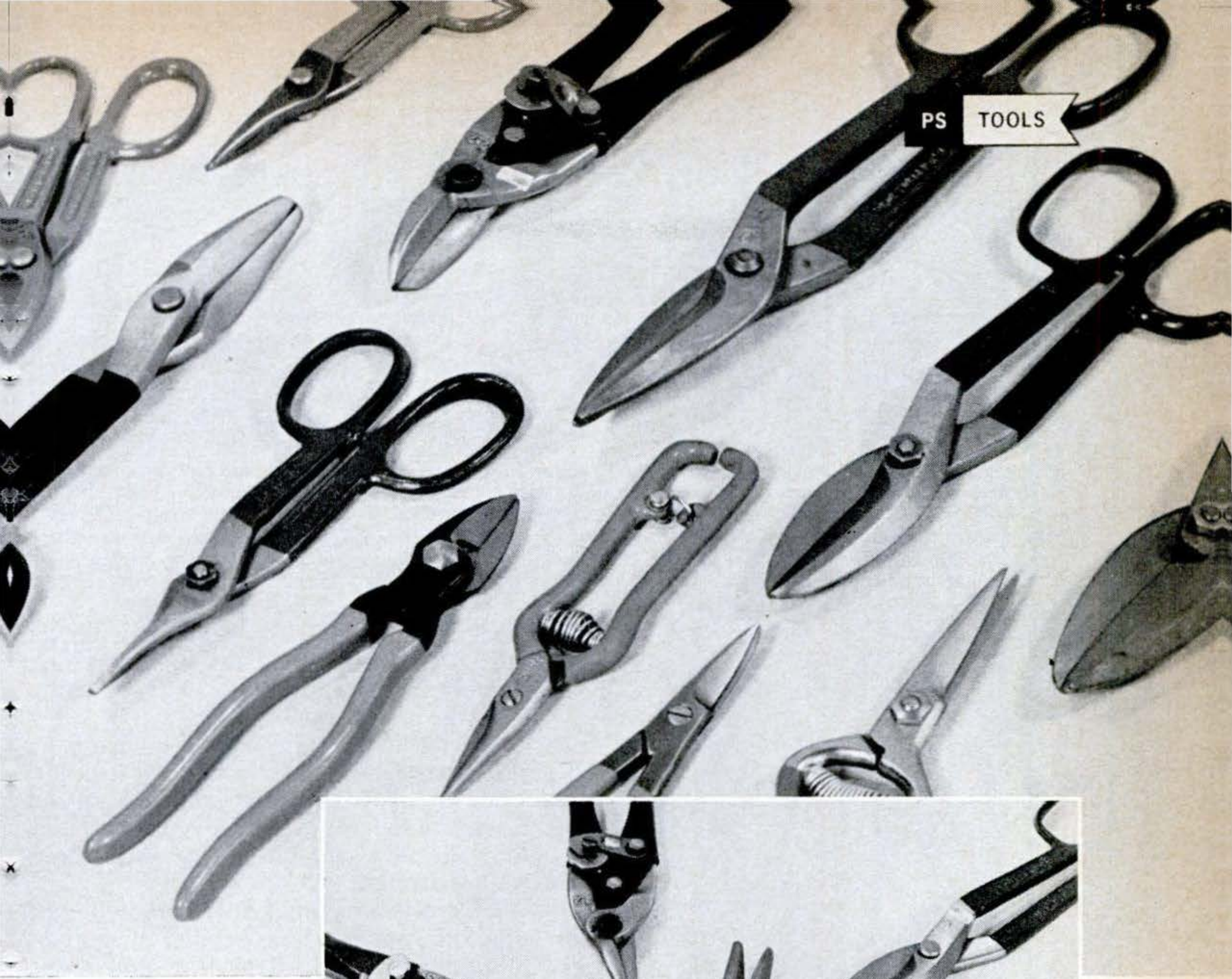
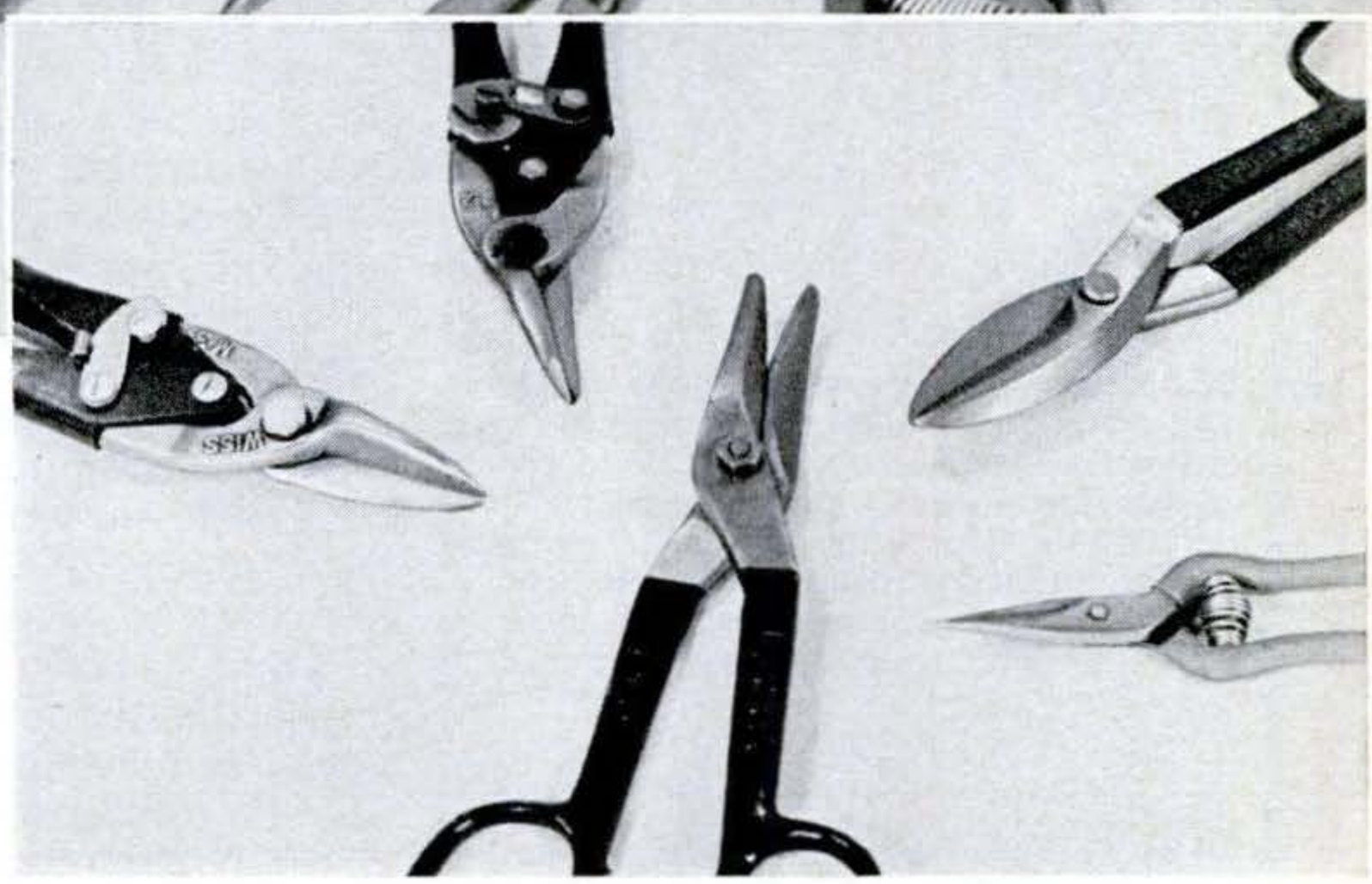
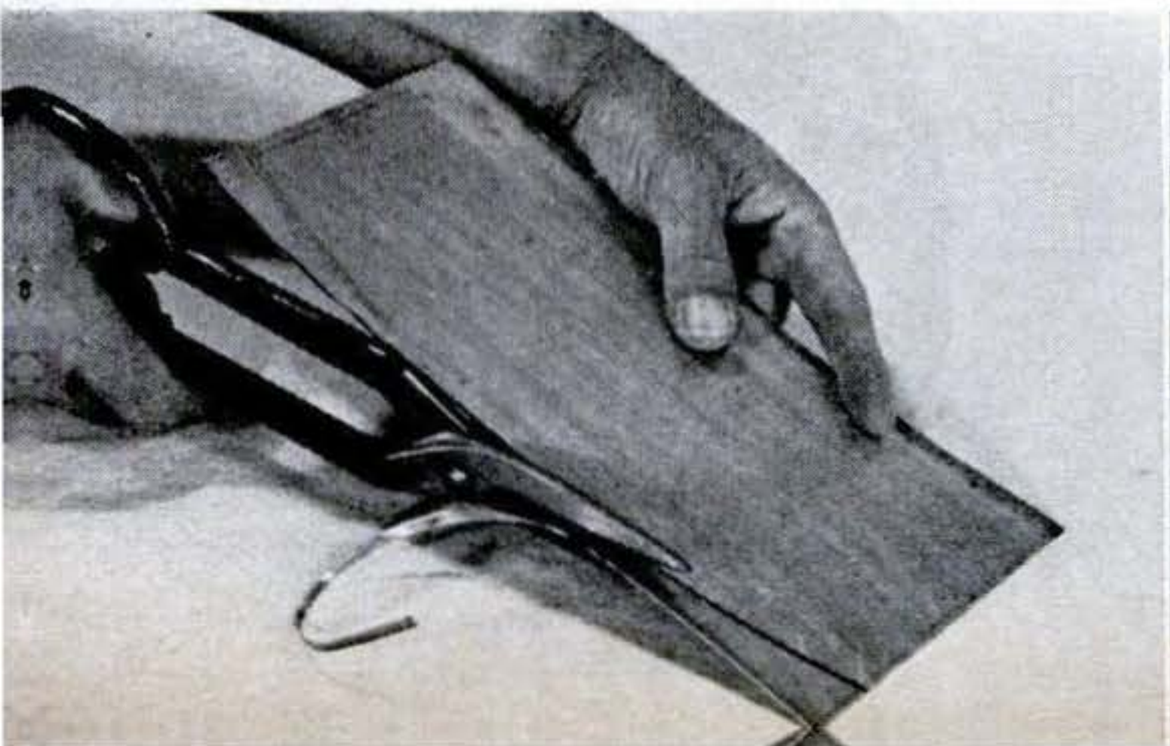
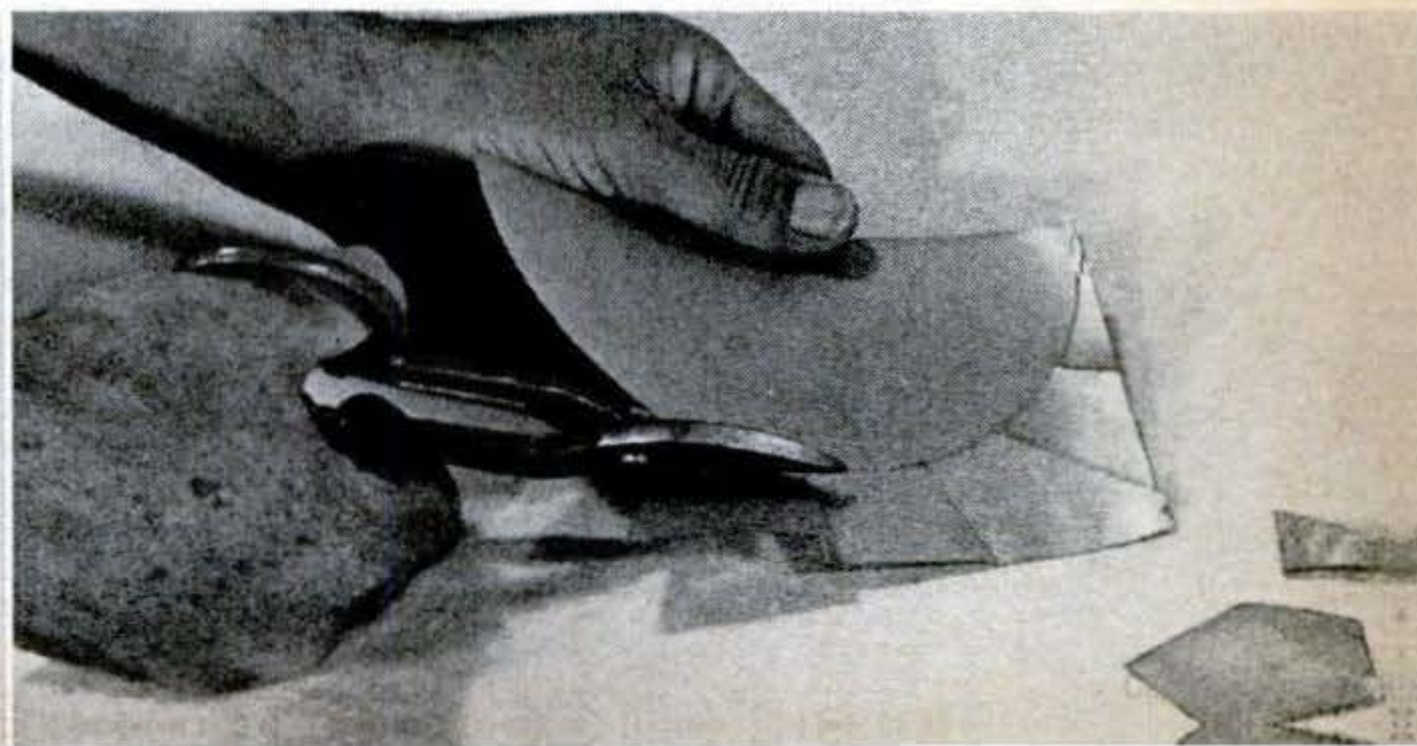


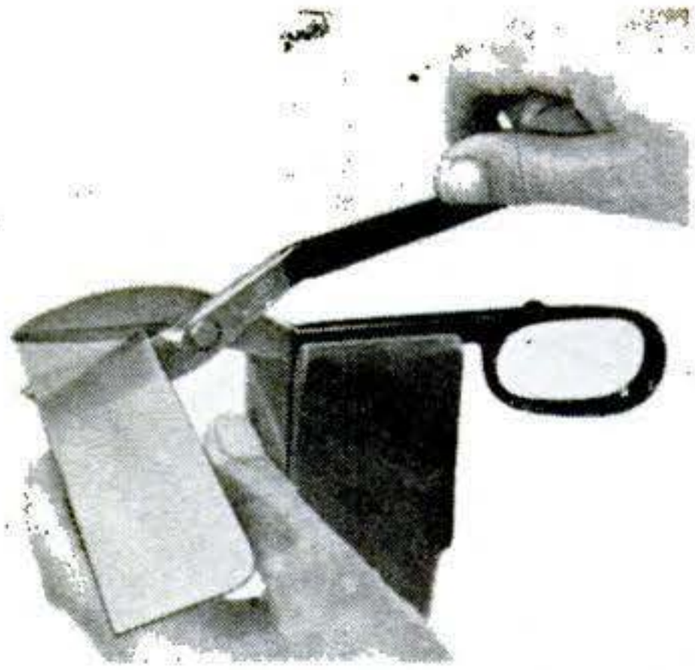


A variety of snips are available, as you see above. A good selection for the well-equipped home shop might include those at right. In the center is a duckbill, a good first choice for some. At upper left are a set of left-hand and right-hand compound-action snips; at upper right, regular pattern; below it, a light-metal cutter.

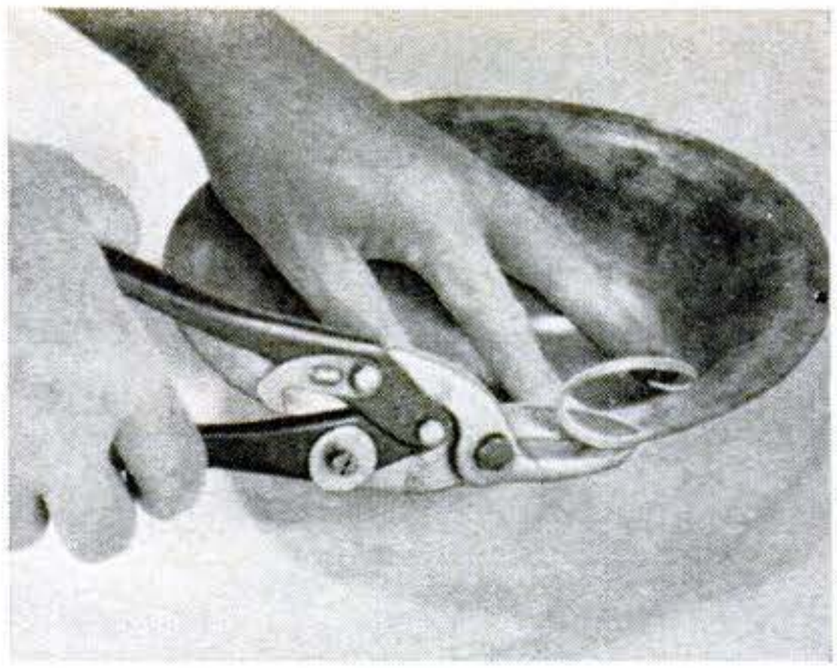
Straight snips can be used to cut large-radius outside curves as you see below. If you find yourself twisting the snips away from the vertical to follow the line, the curve is too sharp. Don't use straight snips on inside curves. If curve is too sharp for the snips on hand, you can probably do the job by making radial cuts first. This drops off pieces of metal and lets you turn the snips to follow the line.



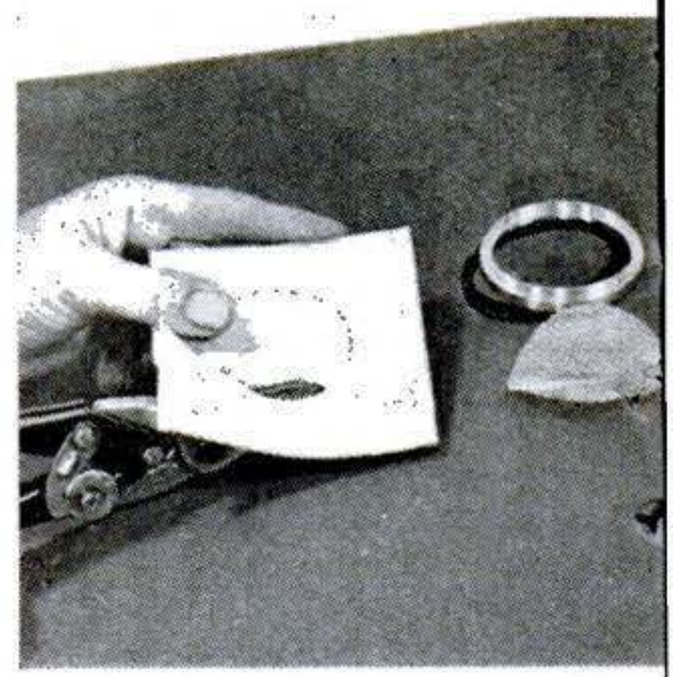




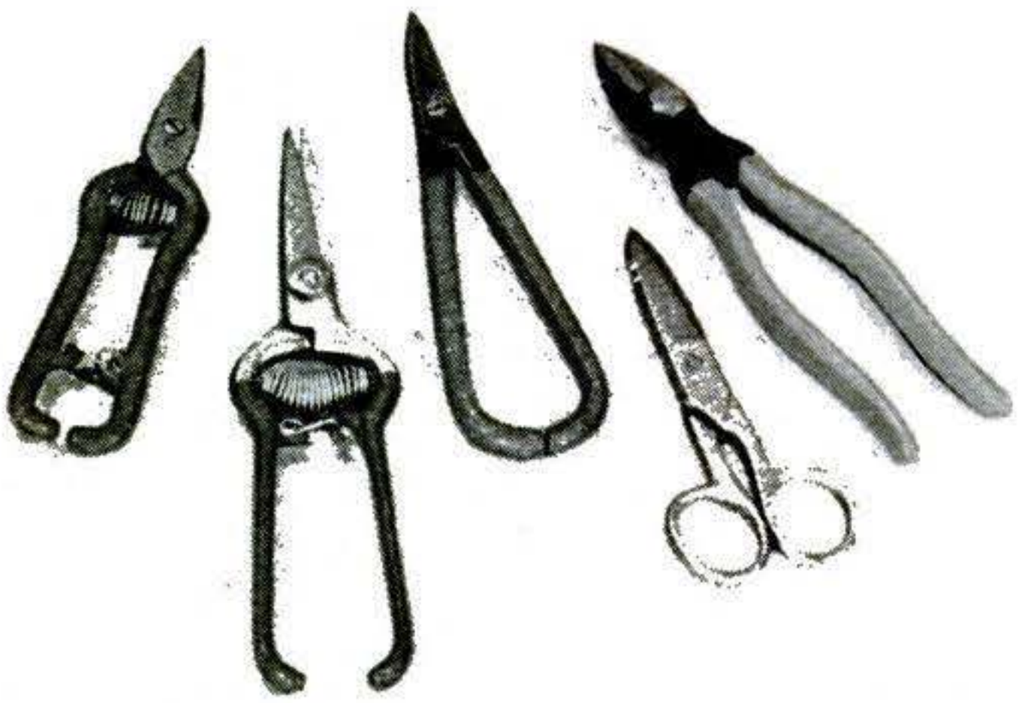
It's okay to grip lower handle of a pair of snips in a shop vise as shown above when you make short cuts in heavy metal. This enables you to apply additional pressure without undue strain on the snips.



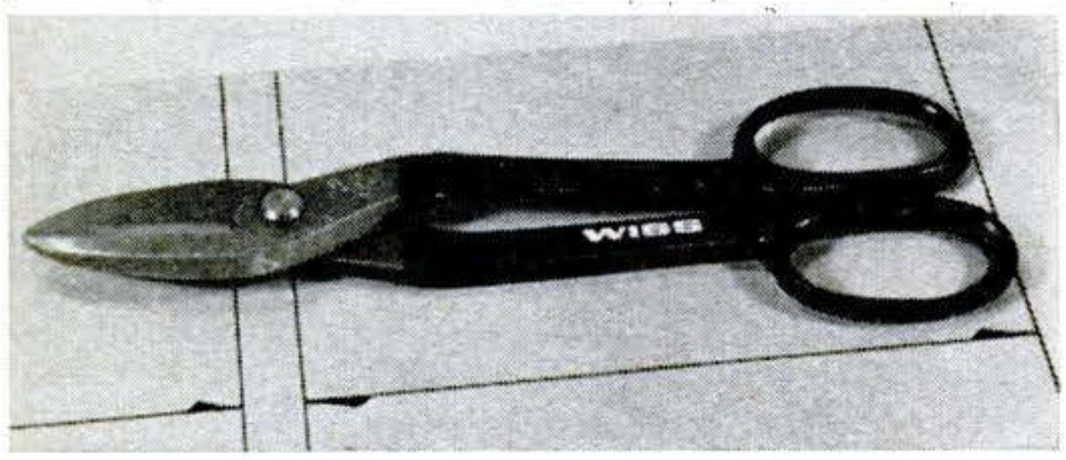
Compound-action snips come close to being all-purpose snips. It's possible to cut intricate curves or straight lines. You apply pressure with less effort. This pair adjusts for use with high or low pressure.



A trick for cutting special shape in wire screening and similar materials is illustrated above. Tape the material to thin cardboard on which you have outlined the desired shape. Then cut through both



Special-purpose snips are available for a variety of jobs. Here are five examples. From left to right are miniature metal shears by P&C, electronics shears by Wiss, light metal snips with curved blades from Wiss, electrician's snips with notches for stripping wire, and a cutter for electrical armored cable. Important: Use a pair of snips only for its designed purpose, not for cutting such things as nails.



Force ratio of snips: It's the relationship of the distance from the blade throat to pivot (two adjoining lines in photo) and from pivot to handles. If this ratio is 10:1 and you have 75 pounds of hand-power, you can exert a force of 750 pounds at throat. These Wiss snips have blades of high-carbon tool steel welded to handles.

blades. These allow a greater amount of lateral motion when cutting. Therefore, they're more suitable for curve-cutting than the straight ones.

The duckbills. These have blades that, in a general way, taper from pivot to point. They are made with beveled blades so you can move to left or right as you cut. Thus, they are very suitable for curved lines as well as straight.

I like them for light-duty cuts in metals up to 25 gauge and have found them quite handy for shaping floor tiles and doing similar jobs.

Special types. As always, there are tools that are exceptional for a particular job and that you'll sometimes wish you had, right now. But total use must justify the purchase.

There are compound-action snips made especially for forming openings in sheet metal or ducts and for cutting light-metal tubular forms. A type made by Wiss has a special piercing tip and a blade that shears on both edges to cause a 1/8-inch strip of

[Continued on page 210]

Newcomer to metal-cutting field is Bernz Cutter, now at hardware stores. Deluxe kit with pistol grip and three interchangeable blades costs less than $8. Knob controls clearance between blade and twin anvils. Another version cuts plastics.

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SHOP TALK

By ROBERT P. STEVENSON

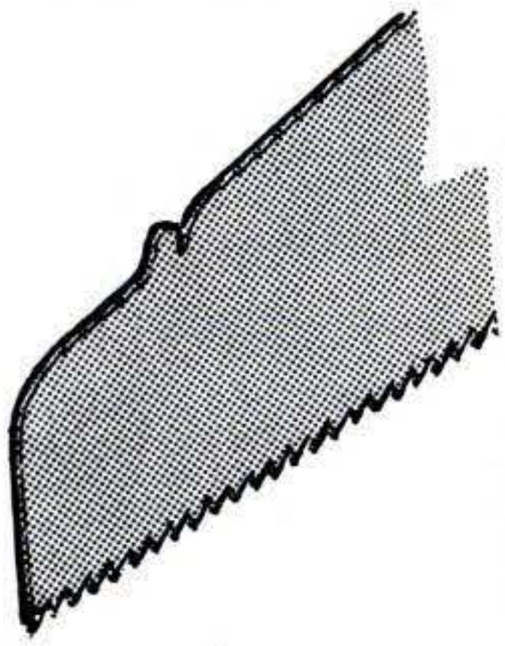
Fireproof paint all through your house? It may be on the way

A news announcement from Philadelphia's Franklin Institute raises the interesting possibility that all good-quality interior paints eventually may have the bonus of being fireproof, or perhaps the better word is fire-retardant. "Fireproof paint with all the qualities of leading trade paints will no longer have to carry a premium price tag," the announcement says. Reason: A new fireproof resin introduced by the Inorganic Resin Mfg. Co., Philadelphia, is priced low enough so that formulators could use it without raising prices. The Institute's Research Laboratories have made tests on sample paint formulas made up with the resin and found them to have such desirable qualities as washability, abrasion-resistance, durability, and decorativeness—all qualities that you find now in quality paints that are not fireproof.

Pitch, roll, or yaw, silicone-rubber steadies tackle box in boat

Fishing-tackle boxes made of corrosionproof plastic are a big improvement over metal ones, but they still slide across the deck of a pitching boat. Dow Corning reports that the company's silicone-rubber sealer can keep a box steady. Using a squeeze tube, apply a bead of sealer the length of the bottom runners, and spread it thin. The flexible coating then will grip the deck, even when wet.

Function of a "nib" on handsaw? Just decorative, maker says



Good handsaws well cared-for last for years. On some older ones you may have noted a projection on the back edge about three inches from the small end (see sketch). A note from Henry R. Rosenblatt of Newton Centre, Mass., reminds us that oldtimers often insist that this "nib" had a function—a nail-puller, rafter cutting gauge, scriber, or other possible use. Not so, he says, and officials at Disston confirm this, supplying a copy of a page from *The Saw in History*, published in 1921 by Disston, which includes this passage: "Of what use is the nib near the end of the handsaw? It is of no practical use, merely serving to break the straight line of the back of the blade and is only ornamental." Disston used nibs on most saws until 1928, when it introduced narrow blades to replace the old-style, wide ones.

Those left-handed monkey wrenches were not a joke after all

My note some months ago about the old practical joke of sending a new apprentice for a nonexistent left-handed monkey wrench brought a response from Henry A. Lesieur of Rochester, Mass. The Handy Wrenches Co. in New Bedford, Mass., made such wrenches, he reports, adding, "I know because I made the special screws for the wrenches in the Morse Twist Drill and Machine Co., also in New Bedford."

What do you know about aluminum nails? New booklet tells all

You can buy aluminum nails to match the color of the exterior material you are applying. Chip-resistant paint is baked on. This is one of the facts in *Why use aluminum nails?* It's free from Publication Dept., Aluminum Assn., 420 Lexington Ave., New York, N.Y. 10017.

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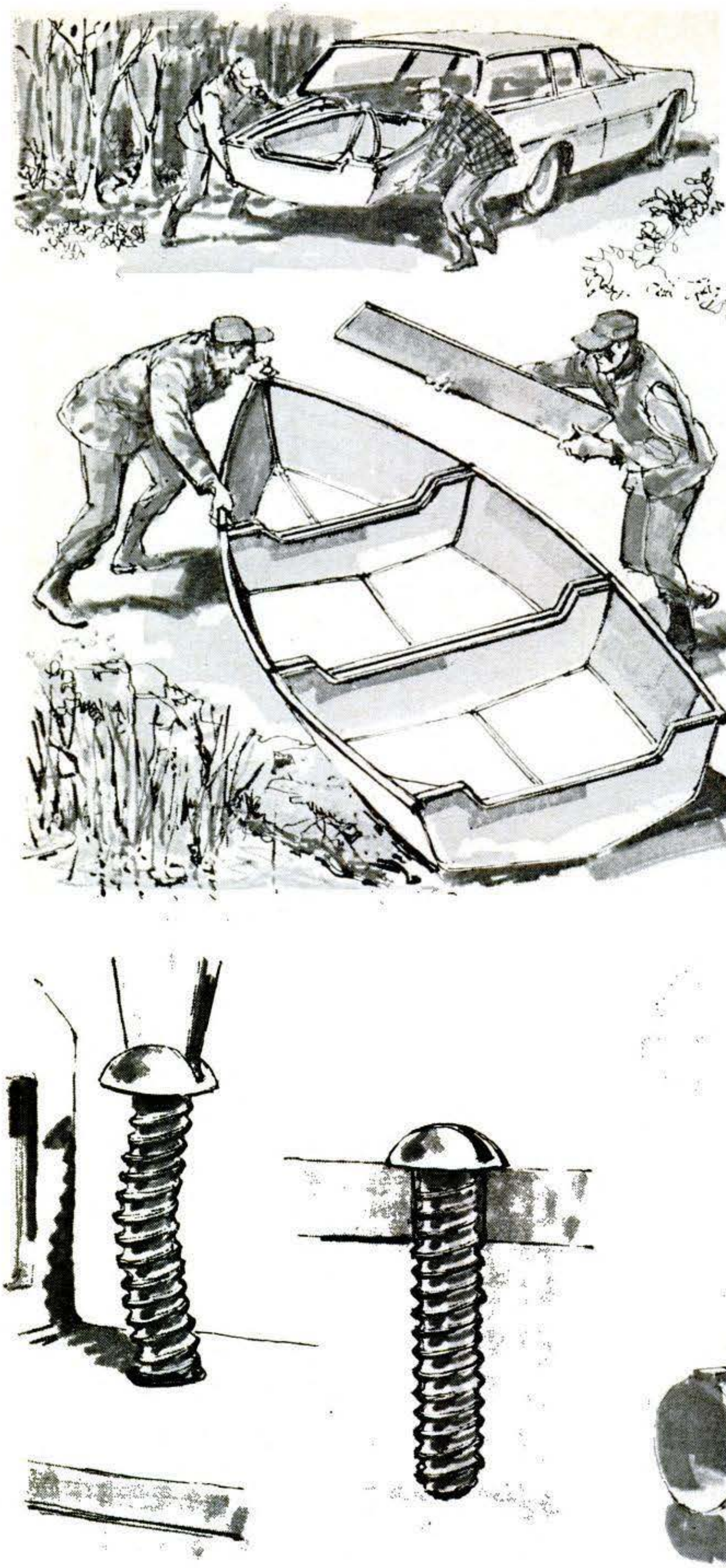

New Ideas from the Inventors

DRAWINGS BY
DANA RASMUSSEN

Nesting sections build boat. The buoyant units of this recently patented boat would collapse for compact haulage, but could be assembled quickly into a full-size craft. Each floating section would have sides, bottom, and a transverse wall. Cables passing through tubes along the sides and bottom would hold boat together; the cables could be tensioned by a screw in the prow.

Coiled screw locks itself. Forming the shank of a machine screw into a spiral, says the inventor, this device will reinforce the pressure of the threads in a tapped opening. The result is that vibration is much less likely to loosen the screw, nor would the gripping power be lost even if the screw were repeatedly withdrawn and redriven.

Extension head aims flash. Connected to the cylindrical body by a semirigid band, the snap-off head of this flashlight would be bent up or around to face in any direction. Batteries would be enclosed in the body in the usual way. A magnetic foot would clamp the light to nearby steel—a tool or car, say—or steady it on any flat surface.

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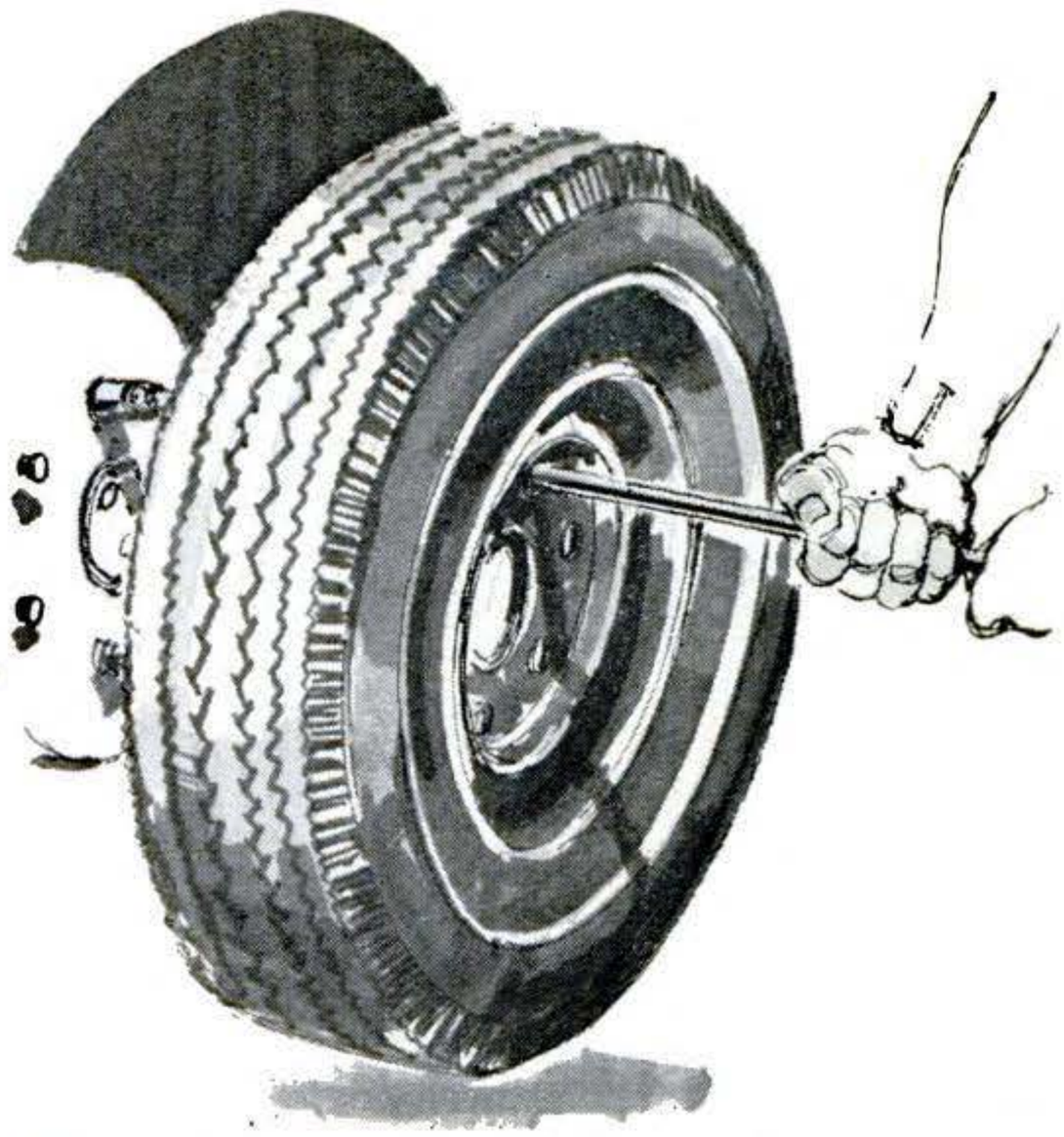
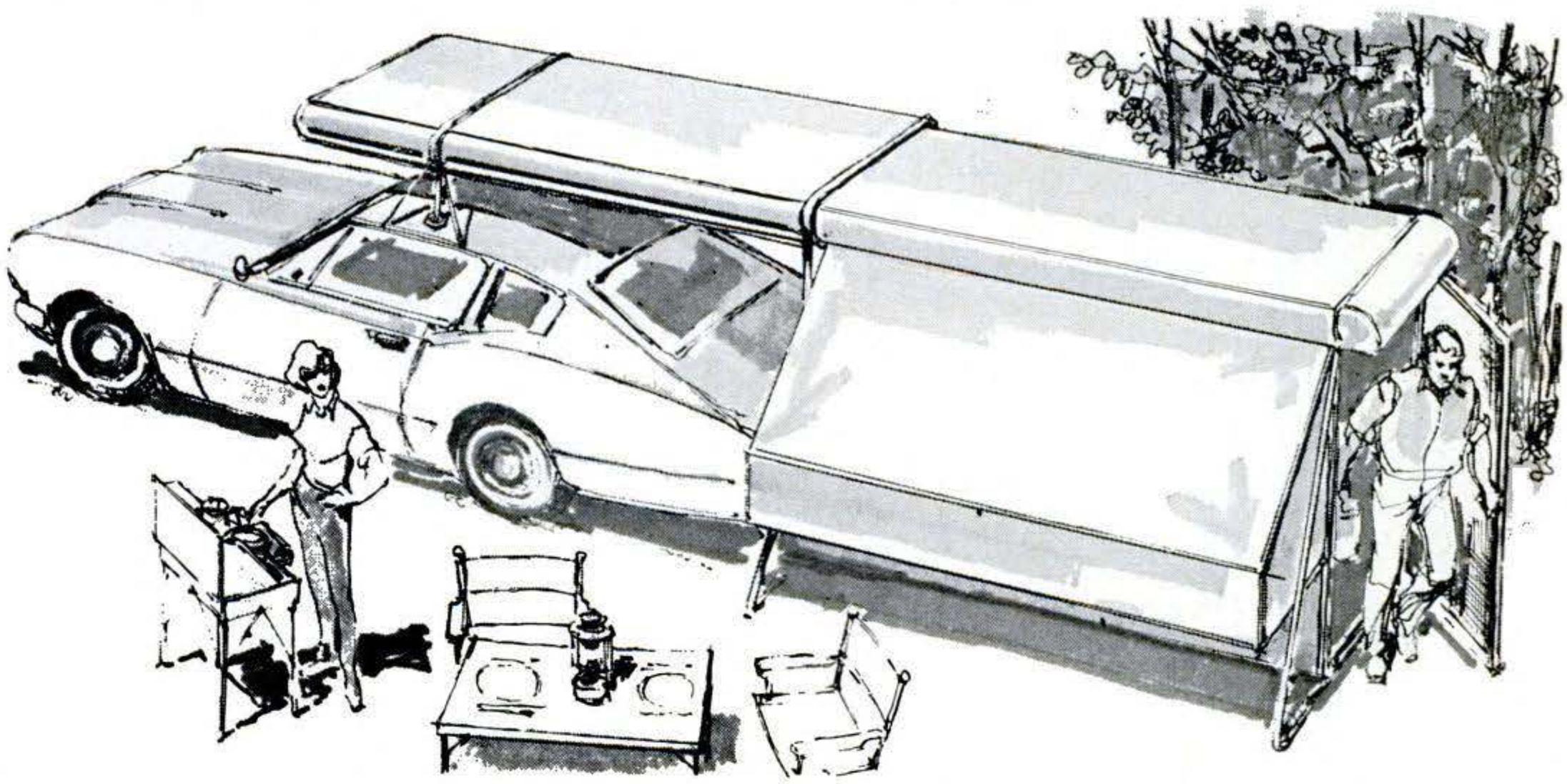
Cart works in store and out. Shopping lines might move faster if a single convertible cart could be used to gather groceries and wheel them home. Auxiliary wheels would support this wire basket horizontally, then collapse when the basket was tipped vertical. A fold-out wall would close the back or the bottom as needed. Cart would fold in the usual way for in-house storage.



Threaded rod helps lift tire. A screw-on cap at one end of this tire-changing tool would let you engage the stud, then simply lift and lever the new wheel into position. A flexible joint just back of the cap would simplify alignment with the wheel hole. For cars with bolt sockets instead of studs on the drums, the tool could be fitted with a threaded, matching lug.



Car-top carrier carries camper. Pulled out from its streamlined carrier, this camping shelter would set up quickly to form a covered central living area and provide two enclosed, let-down cots in the flared wings. Folded into the carrier, it would leave room for other gear and would cause minimum interference with handling of the car.

The following patents have been issued on these inventions: **Nesting boat**—*No. 3,381,322 to W. Cook, Osceola, Ind.;* **Convertible cart**—*No. 3,388,920 to L. Hill Sr., Hollis, N.Y.; E. Eskridge, St. Albans, N.Y.;* **Tire tool**—*No. 3,389,453 to C. Tarter and W. Walker, Healdsburg, Calif.;* **Adjustable flashlight**—*No. 3,393,311 to F. Dahl, Inglewood, Calif.;* **Spiral screw**—*No. 3,391,720 to M. Morse, Fort Lee, N. J.;* **Slide-out camper**—*No. 3,394,-719 to H. Hansson, Rutland, Mass.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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Winterize Your Home On Wheels

[Continued from page 173]

needed, your dealer's shop should be much less rushed. All types have linings that may need replacing.

While each wheel bearing is off, inspect and repack it. Look hard for chips or dents on the surfaces of the rollers and for scoring of the races (the surfaces the rollers bear on). In repacking, don't just rub grease on the surface of the roller cage but be sure to work it in well so that the rollers are encased. Don't use ordinary cup grease; it will drain out under heat and pressure. A dry bearing can twist a spindle right off the axle; not a pleasant thing to have happen at 60 m.p.h.

Motor homes. They're more of a problem because they have an expensive engine to protect. (This also applies to pickup campers if truck as well as camper is bedded down for the winter.)

The following pointers are based on information supplied by Chrysler Corporation, on whose Dodge chassis many motor homes are built. These procedures are for storage over 90 days, which is what winter layup amounts to for most owners.

1. Check the cooling system for leaks and correct any you find. Put in enough antifreeze for the lowest possible temperature in your area, or enough that the antifreeze is at least 25 percent of the entire coolant volume, whichever is more. There must be enough coolant to come above the baffle plates in the top of the radiator. Chrysler doesn't specify the ethylene-glycol type, but I recommend it. A good alcohol antifreeze with rust inhibitor would be okay for layup, but it would have to be drained before you could safely operate at summer temperatures.

2. Fill the gas tank(s) and add one quart of combination crankcase detergent-rust inhibitor for each five gallons in each tank. Chrysler suggests their part No. 1643271. If your dealer doesn't have it, he probably has an equivalent. Then change the oil and oil filter, adding eight ounces of the same product to the new oil. Run the engine for about five minutes at 1,000 r.p.m. (fast idle).

3. Disconnect the gas line at the fuel-pump inlet and run the engine at 1,000 r.p.m. until it dies of starvation.

4. Get the wheels up on blocks, leaving normal pressure in the tires.

5. Remove each spark plug and pour two ounces (four tablespoons) of crankcase detergent (see No. 2) into each cylinder. Spin the engine with the starter for a couple of seconds to coat the cylinder walls with oil, then replace the plugs.

6. Take the tension off all belts on the front of the engine, such as the fan belt plus those driving power steering, air conditioner, etc.

7. Give the chassis a complete lube job.

8. Every 30 days during layup, put the transmission in gear (have someone hold the clutch pedal down on stick shifts) and rotate one rear wheel for a couple of revolutions. This will prevent rust by keeping transmission and rear-end gears coated with lube.

Maybe exercise her? If you find these procedures a bit much, you can skip the last five steps if you run your rig at normal highway speeds for at least one hour every 30 days. Since this involves removing and replacing the battery each time, it's less work in the long run to tackle the full treatment.

The worst thing you can possibly do—and Chrysler specifically warns against this—is to run the engine for short periods of time during layup. This will only aggravate wear on pistons, cylinder walls and bearing surfaces. Either give it a good running or forget starting the engine.

Detroit also speaks true when they tell you to keep cooling system and gas tanks full. Antifreeze protects your engine from corrosion, while draining it only increases this danger. Likewise a full gas tank is protected against moisture condensation and all the attendant evils of water in the gas line. If you're worried about safety, consider that the mixture of air and gasoline vapor in a nearly empty tank may be more dangerous than a tankful of liquid gasoline. The liquid will only burn; the vapor can explode.

Whatever kind of rig you have, your layup activities may reveal the need for repairs or routine maintenance such as painting. If so, this is the time to take care of it. Whether you do it yourself or have it done, there's more time available at this end of the season, and you'll be all ready to roll on the first pleasant weekend next spring. PS

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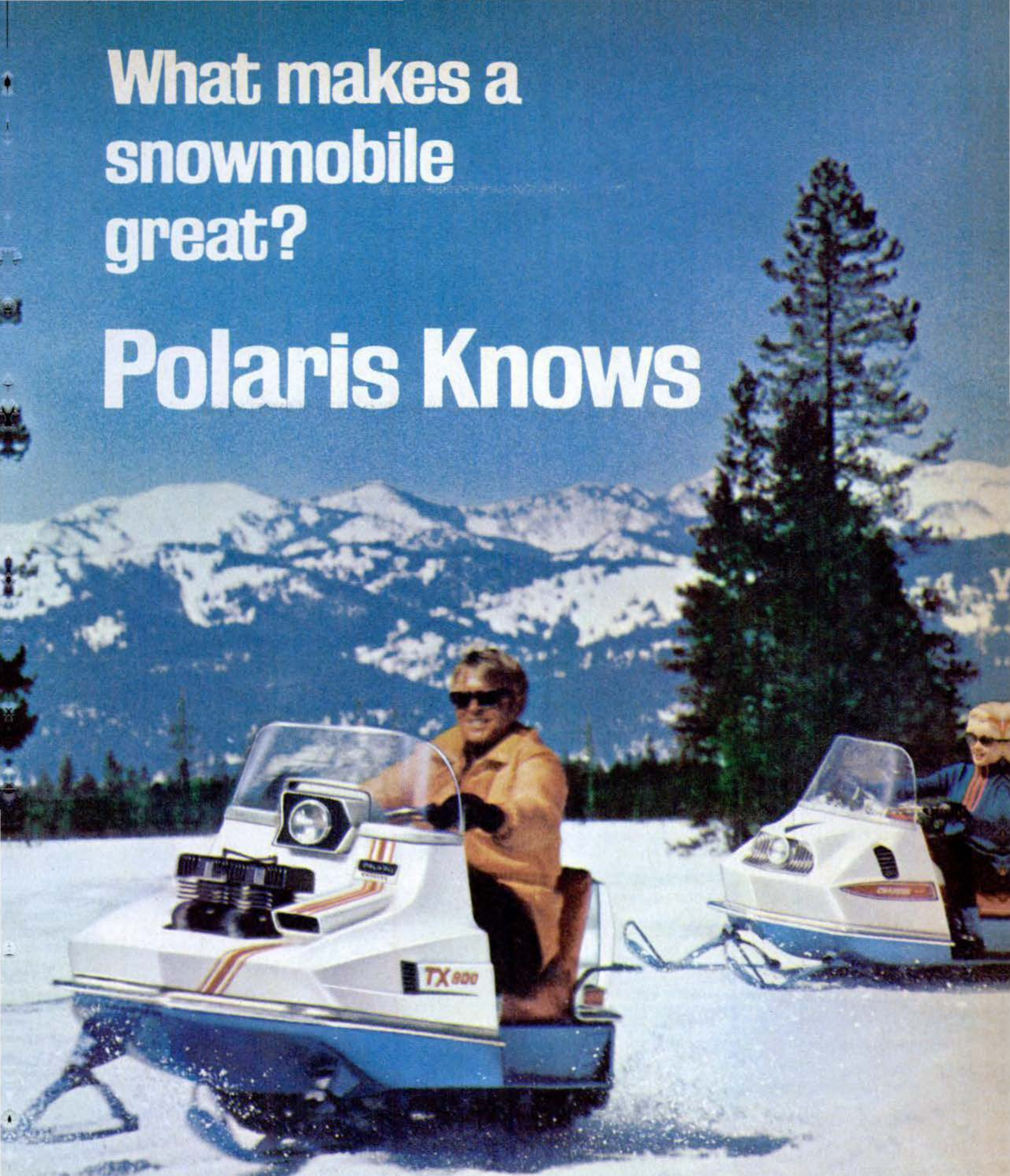
What makes a snowmobile great?

Polaris Knows



Say it in one word. Performance. A get-up-and-go snowmobile that turns any stretch of snow into an open highway. One word, but a dozen design refinements in the '70 Polaris make it happen. Like powerful twin-cylinder Star engines, new Drift-Skipper suspension, Polaratone muffler, and dependable electric start. These are just a few of the pace-setting innovations in the 1970 Polaris. Take a test drive. You won't risk anything but temptation. Polaris Industries, Roseau, Minnesota. A Textron Division.

TAME A POLARIS ON THE PONDEROSA

Win a trip for two to the Ponderosa Ranch of "Bonanza" TV fame. Register at your Polaris dealer.

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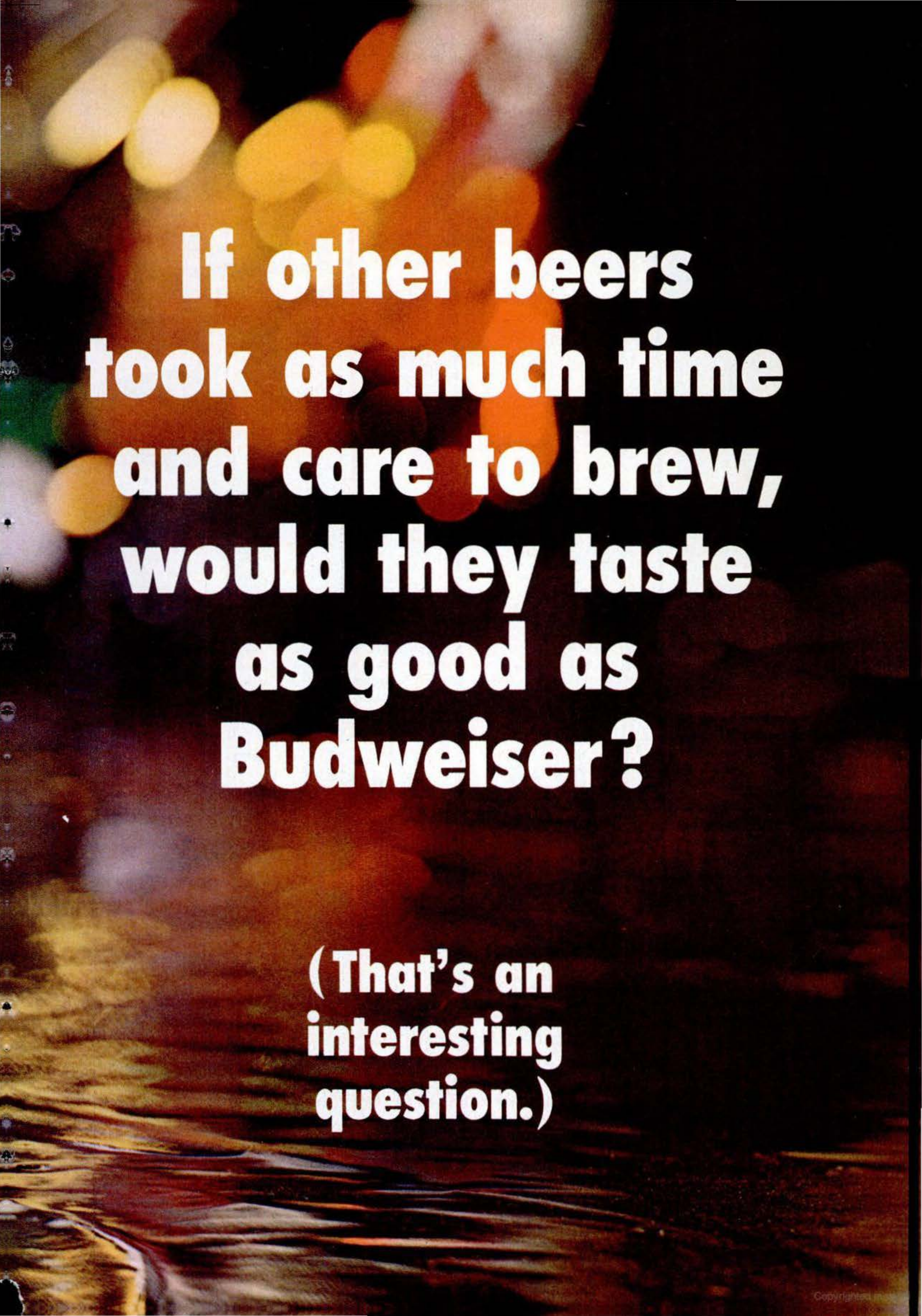
If other beers
took as much time
and care to brew,
would they taste
as good as
Budweiser?
(That's an
interesting
question.)

Guns you now can buy: At left, United Shoe's big gun with three-level temperature control, neon reminder light, and trigger control of glue flow, $22.95 with 60 sticks. Center, Swingline gun with three-level temperature control, off switch, and trigger-feed; insulated wrench turns nozzle on or off to control glue flow; with 14 glue sticks, $8.95. Right, USM's small model, $7.95 with four glue sticks.

Good Jobs You Can Do with a GLUE GUN

The electric glue gun not only enables you to do gluing jobs faster than ever before—it compels you to. You can put a project to use just one minute after you've glued it together, as the gun's cartridge-type adhesive reaches 90 percent of full strength in just 60 seconds. (It develops the remaining 10 percent overnight.) But, because of this fast setting time, every gun-bonded joint you make must be assembled within 20 seconds after the glue is applied. This, fortunately, is easier than it sounds. Watch the sweep hand of your watch and you'll see that even 10 seconds is ample assembly time for most joints.

Hot-melt adhesive of the type used in the guns, however, behaves differently than the liquid forms we're accustomed to using. Its strength is in the 200-300-p.s.i. range, much lower than most modern liquid glues. Yet it produces about a ¼-ton grip in two square inches—ample for most cabinetwork and shop jobs. And it sticks to anything—except a few glue-defying plastics. Also, it's completely waterproof and it's an excellent gap filler in loosely fitted joints.

Continued

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Chevrolet put it all together.

Solid gentlemanly comfort without bombast. Sailplane silence.

Computer-selected coil springs for a ride that glides.

Yet Monte Carlo's handling leaves you feeling like anything but a fifth wheel. A taut 116″ wheelbase and a track five feet wide go where pointed. Precisely.

And powerfully: a 350-cubic-inch V8 is basic. (Order on up to a 454.)

Standard is an instrument panel with the rare look of hand-rubbed burled elm.

And Astro Ventilation.

Even power disc brakes, fiberglass-belted tires and higher intensity headlights.

Nothing's missing.

Nothing except the fat you find on fat cars at fat prices.

Monte Carlo.

The only car in its field. Period.

Putting you first, keeps us first.

CHEVROLET
On The Move.

A group picture of all the cars in Monte Carlo's field.

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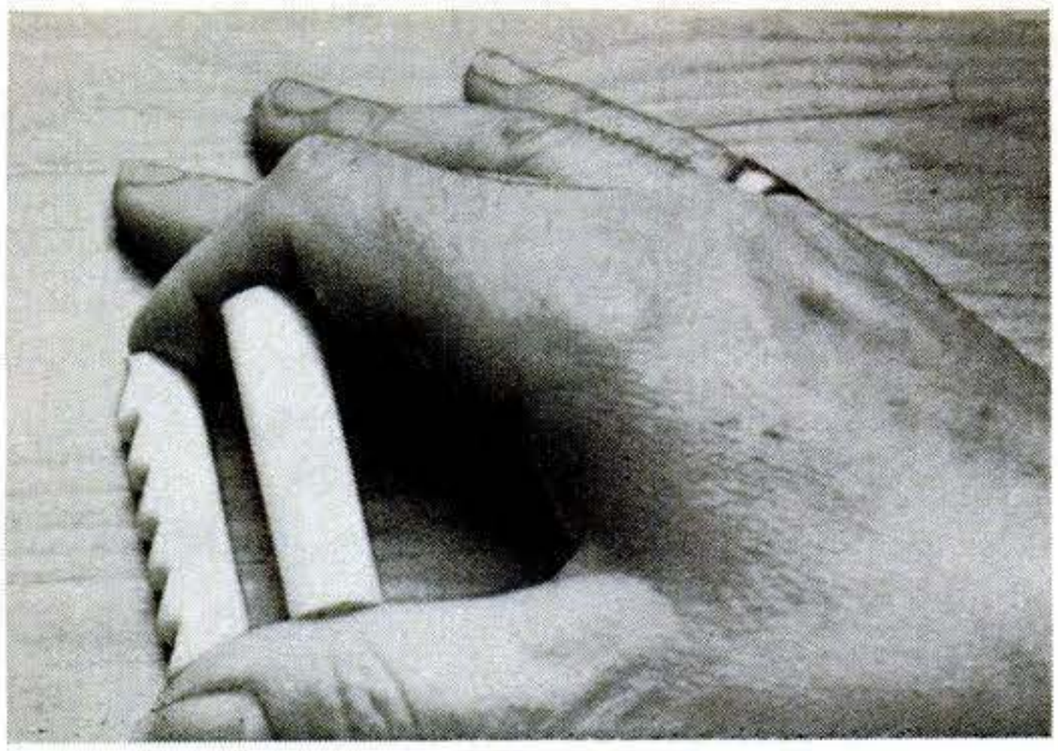
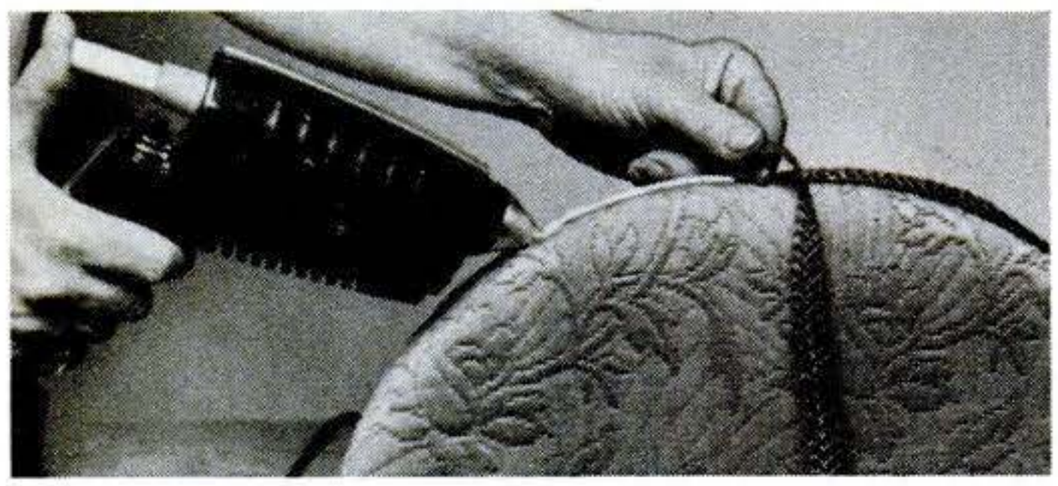
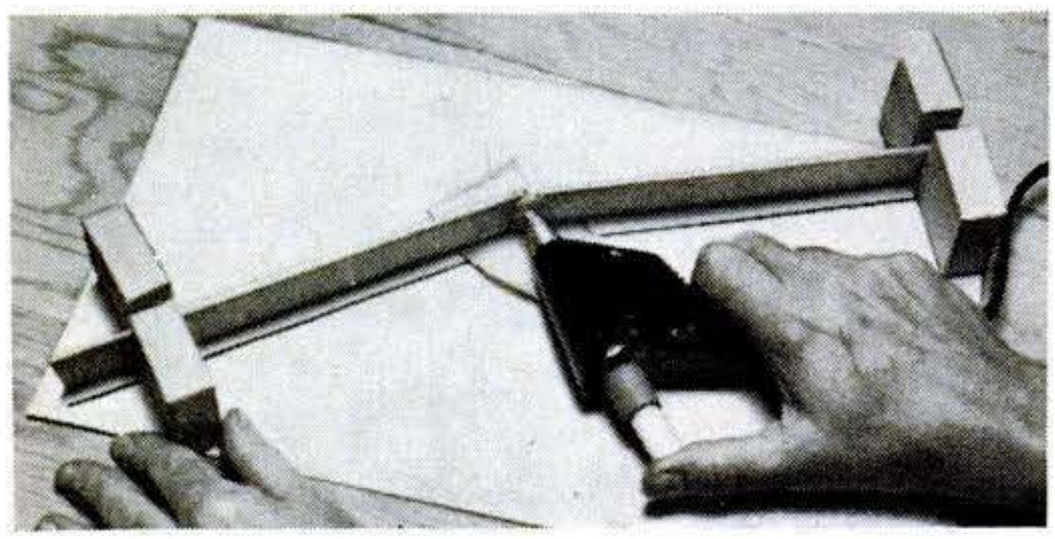


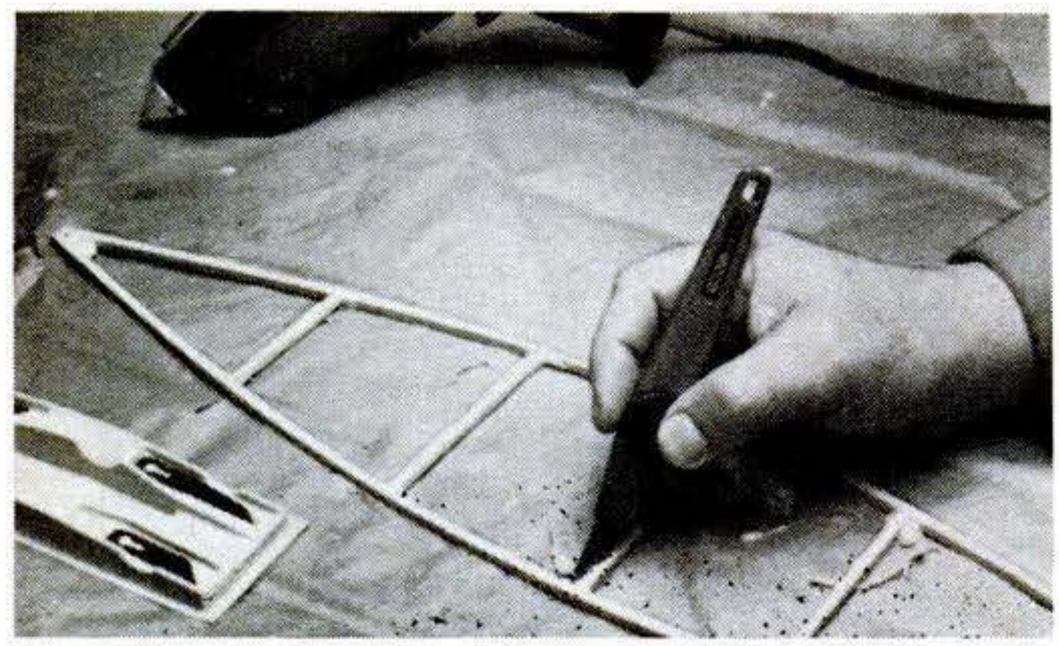
Two types of glue sticks: At left is Swingline's trigger-feed form, notched to be moved in ratchet fashion by trigger. Plain cylindrical type is USM design. It's moved into gun by thumb pressure.



In upholstery work, a glue gun provides instant adhesion for gimp and other trim. Gun is big USM.



High-stress joints like wing center in model plane are a cinch. Work can be gun-glued in any position, even in jig. Reinforcing shell can be built up with glue, then thinned to skin thickness with hot nozzle.



In light-model-framing work, trim off excess glue at joints after cooling, using a modelmaker's knife like this Stanley. Always use paper under gluing work to keep it from sticking to the bench.

But it requires its own bag of tricks. Use it improperly and you can break the joint apart with your fingers. Use it properly and you'll need a sledge hammer to smash the bond.

The secret: When you use a glue gun with its hot-melt glue, think in terms of heat. On gluing areas up to about 3/8" width just lay on the bead of hot glue and push the parts tightly together. The pressure squashes the glue bead and spreads it across the gluing area, still hot enough to soak in and get a good bite. (There isn't time to spread it by other means.) On wider gluing areas, however, the picture changes. The gluing surfaces absorb the heat from the thin glue film as it spreads. In the outer areas it chills before it can get a grip. So only the inner portion of the gluing area takes hold.

Preheating the gluing surfaces either with a flatiron or heat lamp (a reflector spot or flood bulb will do) cures the trouble. The nozzle of the gun can also be used to preheat the work in some cases. The gluing surfaces should be hot to the touch, not merely warm.

You can read the rest of the story in the test photos on a following page. The unheated joint broke easily, leaving strips of chilled glue dangling. Put in a vise, the preheated joint had to be hammered apart.

The same general principle applies on all materials: On large surfaces provide enough heat to keep the glue liquefied during the second or two it takes to spread over the gluing area when parts are pressed together. This gives you a full-strength bond. To glue metal, you can apply heat from the outside, as often done in soldering. As soon as the work cools (usually a minute or two), it's ready for use. Typically, you save eight hours of waiting time required for hardening ordinary glues. To join fabric, lay the bead on one piece, put the other piece on top, and iron them together—with the iron set for full heat.

Long glue lines in woodwork. These can't be gun-glued unless the job is planned for it. (The starting end of the glue bead stiffens before the gun reaches the other end.) To plan for long-seam gluing, make a V joint (about five degrees) with the open part up—and flow the bead into it after the parts are assembled. Then pass a

Continued

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To score on snow

what kind of power play do the pros call?

Throw snow farther, faster without wearing yourself out. Do what the pros do; start a winning winter season now. Lion or Viking, Packer or Bear, NFL Pros know the way to guard your back is with a Wheel Horse, of course.

WHEEL HORSE POWER

pick of the pros

Discover Wheel Horse tractoring and fall in love with winter in 4 minutes flat! That's all the ride it takes to clear a 40-foot driveway when you team up with a Wheel Horse snow thrower. Call signals from where you sit with remote-control, revolving (200°) snow chute. Toss snow 35 feet. Solid-state ignition kicks off in any weather, with quick-snap key start. Call an automatic with no-shift hydrostatic transmission. Hydraulic lift puts attachments through their paces without effort. Tackle snow with 9 tractors (7 to 14 HP) built by the people who pioneered tractoring. Call on 7 throwers and dozers for extra up-front protection. 42 all-season attachments for extra yardage in your back yard. Over 3,000 dealers cheering to make this winter a winner for you. *See "Lawn Mowers" in Yellow Pages or phone 800-243-6000 free. In Conn. call collect 853-3600.*

See the 1970 Safari Snowmobiles! Rugged as any Wheel Horse Tractor

2-YEAR WARRANTY: Wheel Horse warrants its tractors & attaching tools to be free from manufacturing defects in normal service for 2 years from date of purchase. (Twice as long as any other tractor warranty you can get today). The Wheel Horse obligation under this warranty is expressly limited to the replacement of any defective part manufactured by Wheel Horse. The defective part must be returned prepaid through an authorized Wheel Horse dealer. Warranty is effective for 90 days if used commercially. Original tractor & tractor attaching tool drive belts are warranted for 90 days from the date of purchase. The engine & battery carry a separate warranty by their manufacturers. All warranty claims, work, shipment of parts, etc., must be handled through an authorized Wheel Horse dealer. Service calls or the transporting of the unit to & from the dealer are the responsibility of the customer.

Wheel Horse®

Tractors/Mowers/Snow Throwers/Snowmobiles

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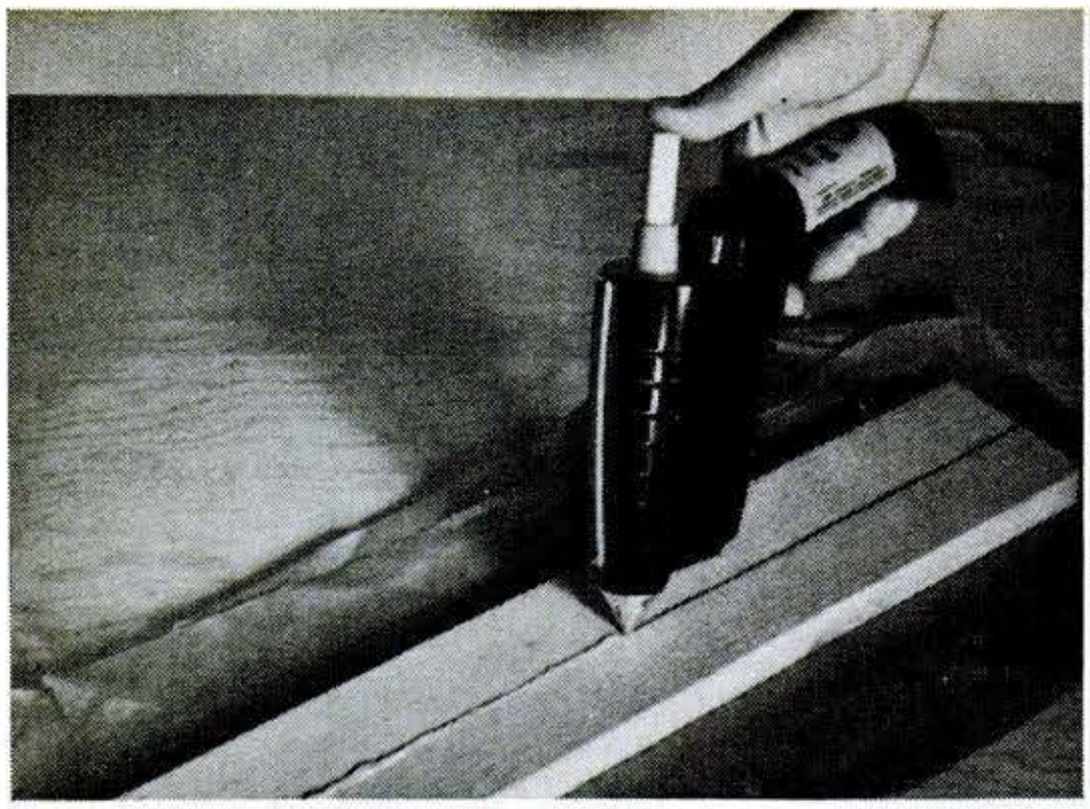
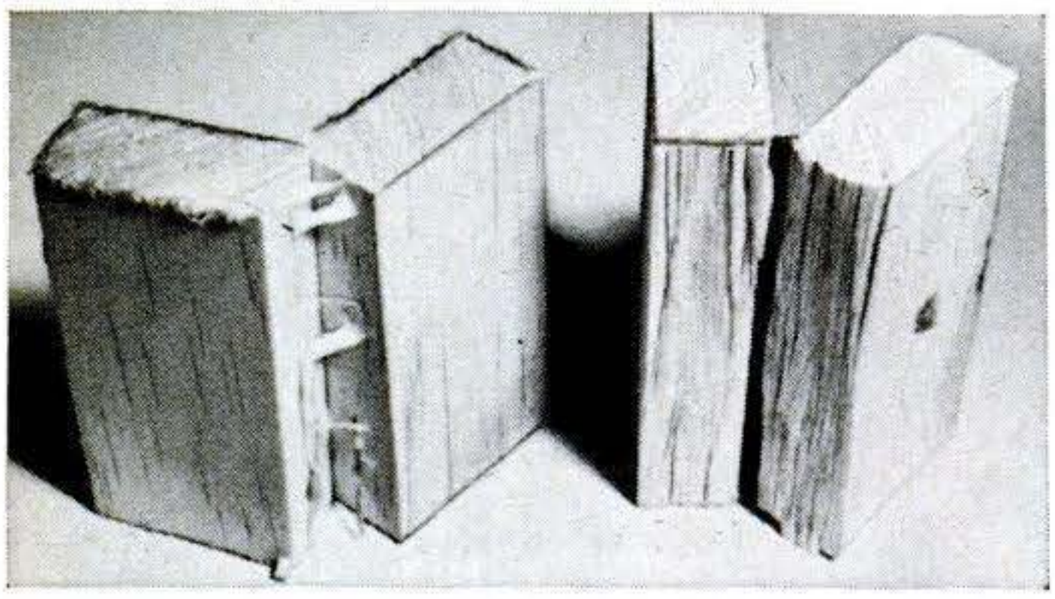
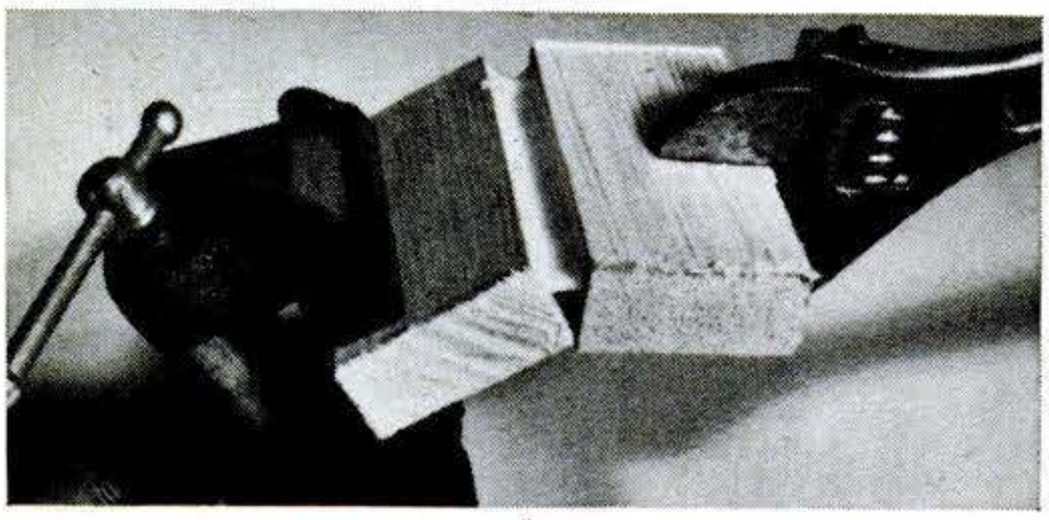


To gun-glue a long seam, make a five-degree V and flow glue along it like this as the first step. The seam may be glued a section at a time. For second step, melt glue bead into V seam with a flatiron. (Glue wipes off easily from iron while hot.) If a second bead is needed to come flush with surface, repeat the process. If an iron isn't available, use the hot gun nozzle. This is slower, but it works.

In wood joints wider than 3/8", preheat gluing surfaces with iron or heat lamp until hot to touch. This assures overall glue spread without chilling.



On cold-formed joint at left, glue peeled off in strips when tested. Joint at right was preheated and glue spread fully. In test, wood broke, not glue.



Gap-filling quality of gun glue is shown by glue spanning almost 3/8" in joint. When joint broke, glue pulled off layer of wood. Glue did not break.

hot flatiron over the bead to melt it down into the V.

For inside-corner seams use the edge of the iron for the melt-in. If a second bead is needed to fill a seam flush, repeat. The glue's gap-filling quality provides a strong bond (but it wipes off the iron easily while hot).

Use the same flow-in method for repairing loose joints and seams. Lay the glue bead along the crack or opening and flow it in with an iron. It works nicely on boat-seam caulking, too, if you can tilt the hull to down-flow the bead.

For dent-filling in wood surfaces to be painted, simply over-fill the dent (slightly) with the hot glue, let it cool, and trim it flush. The glue takes glue, but can't be stained by ordinary methods, so it isn't suited to most natural wood finishing.

Smoothing-off the glue atop seams or dents calls for shaving, *not* sanding. A razor, sharp plane, or Surform brings it down flush and smooth. Sanding makes a stringy mess of it. If you drop a blob of the hot glue where it isn't wanted, remove it as quickly as possible with a knife. Hot or cold, no ordinary shop solvent will remove it.

For decorative effects. Draw the design you want on the surface of the work, then run a glue bead along it, as shown in a photo. You can use the same method to apply raised lettering. You can apply a contrasting color to the surface first. Or you can paint the complete job and clean the raised lines with a felt pad.

Don't gun-glue jobs that will be sub-

Continued

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A Volkswagen dealer will gladly sell you one.

Obviously.

What's not so obvious, however, is why you would gladly buy one.

So we'll give you a little clue:

See that sign by the windshield? That's what you get for buying that thing.

A 100% guarantee.*

Don't laugh. It's a beautiful thing in itself. Because it covers the big things that can plague you in a used car:

Engine. Transmission. Brakes. Axles. And electrical system.

So if anything goes wrong with any of those parts within 30 days or 1000 miles (whichever comes first), worry not.

The VW dealer guarantees 100% to repair or replace it. And it doesn't cost you a cent.

Not every car he gets in trade gets that guarantee, either. Only those that pass a tough 16-point inspection earn his guarantee sign.

Which is your sign. Of a car that's really beautiful.

*The dealer guarantees 100% to repair or replace the engine, transmission, rear axle, front axle assemblies, brake system and electrical system, for 30 days or 1000 miles, whichever comes first.

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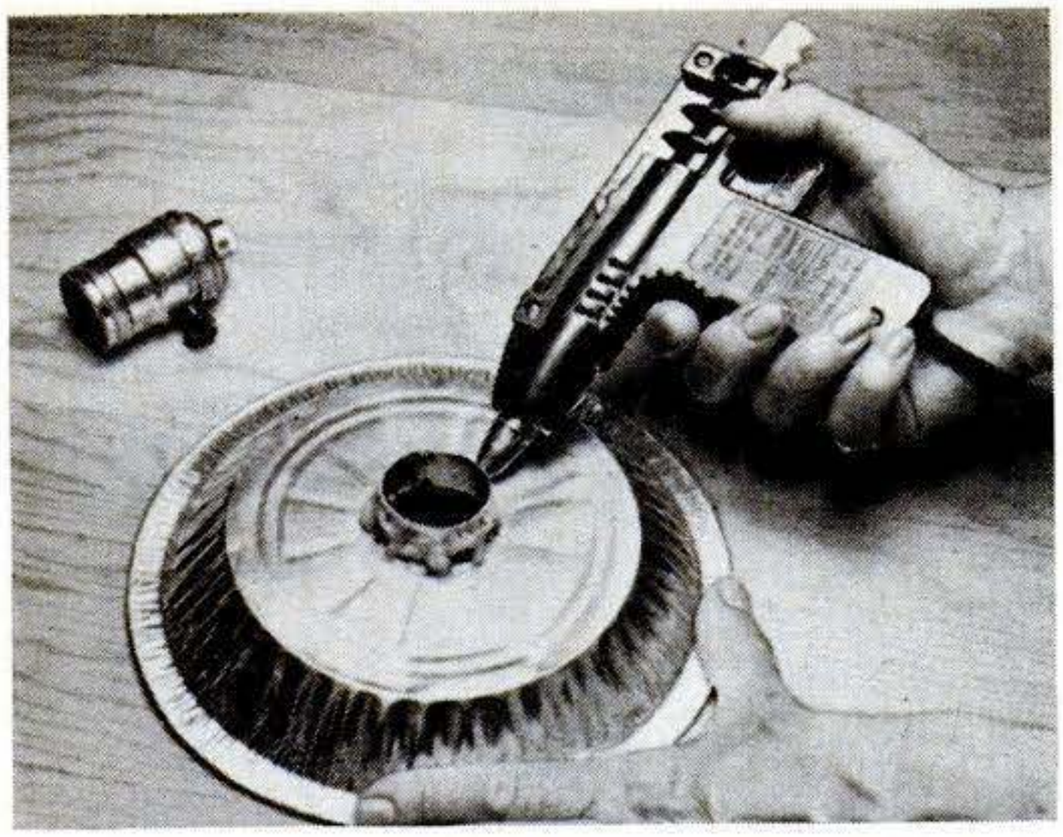
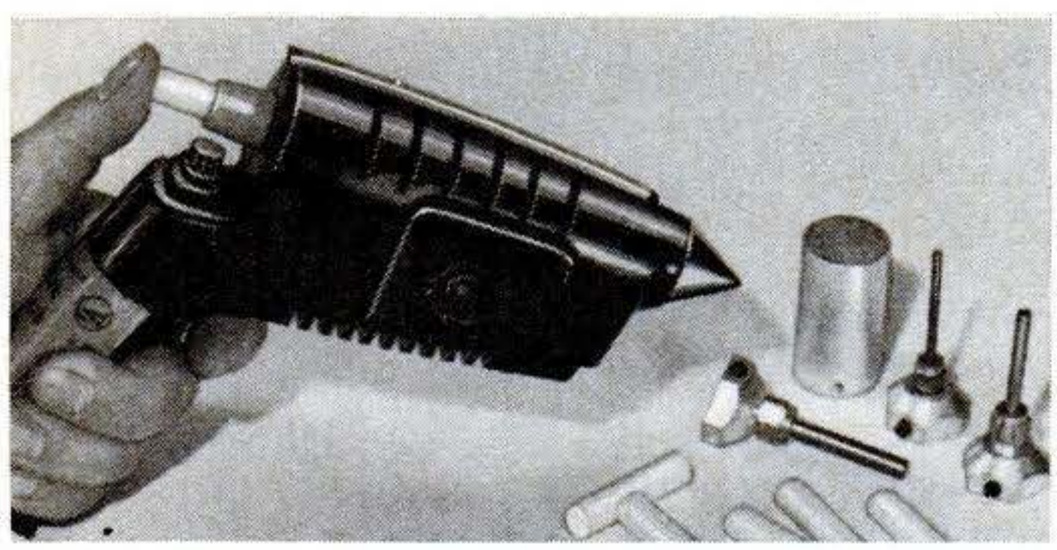


To make a flash reflector for photographic use from an aluminum-foil pie plate, just glue the socket-matching rim into a hole in the pie plate's center as you see here. When working with thicker metal always preheat work, as metal conducts glue away too rapidly for good bond. You can also heat work *after* glue is applied, to flow it out for better grip.

Raised decorative designs or lettering are easy with a glue gun. Just draw the pattern on the surface to be decorated, using a pencil, and then follow lines with glue bead, like this. Handy aid in work: a block of wood drilled to take glue sticks—easy to grab for refill during a job. Gun is USM small model.



USM's big gun is pictured here with the special nozzle assortment that's available for it. The long nozzle tubes are designed to reach into tight spots.

jected to temperatures of 130 degrees or more. And don't wear a bikini or open sandals when you use your glue gun. If a drop of the melted glue (almost twice as hot as boiling water) lands on your skin it will stick and send you through the roof.

Glue guns. Those now available include two by United Shoe Machinery and one by Swingline. Simplest, lightest (eight oz.), and least expensive is USM's Thermogrip model that sells for $7.95 with four sticks of glue. (Additional glue sticks, cylindrical in form, are sold by the box—around $2.50 for 60.) To operate the gun (first type to reach the general market) you plug it in for about a four-minute warm-up, push a glue stick in the rear, and keep pushing it with your thumb to flow a melted bead out of the nozzle.

When the end of the glue stick works down to the insertion tube you dab the end of another with hot glue, stick it to the old one, and keep on gluing. To shut it off, pull out the plug. Newest version has automatic flow control.

USM's big gun costs $22.95 with 60 sticks of glue. It's the only gun that rests in stand-up position on the workbench. A neon light just under the insertion tube reminds you that the gun is plugged in. An adjusting dial gives you a temperature choice of high, low, and medium. (You'll usually use it near high. Low is for idling between stages of a glue job, minimizing warm-up time.) A trigger provides on/off control of the glue flow. Pull the trigger and push the glue stick with your thumb, and the glue is emitted from the nozzle. Release the trigger and the glue stops almost instantly—very handy in keeping glue where you want it *only*.

Swingline's gun (latest entry in the field, $8.95 with 14 glue sticks) also has a three-stage temperature control plus an on/off switch, and a trigger. But its trigger serves a different purpose: It engages the special Swingline ratchet-notched glue stick and moves it into the gun. Instead of pushing the glue with your thumb, you move it along by trigger action. When one stick disappears into the breech, you slide another in behind, and trigger it along. If you want to shut off the glue flow between stages of a job (to avoid dribbling) you use an insulated wrench (supplied with the gun) to turn the nozzle to off position. PS

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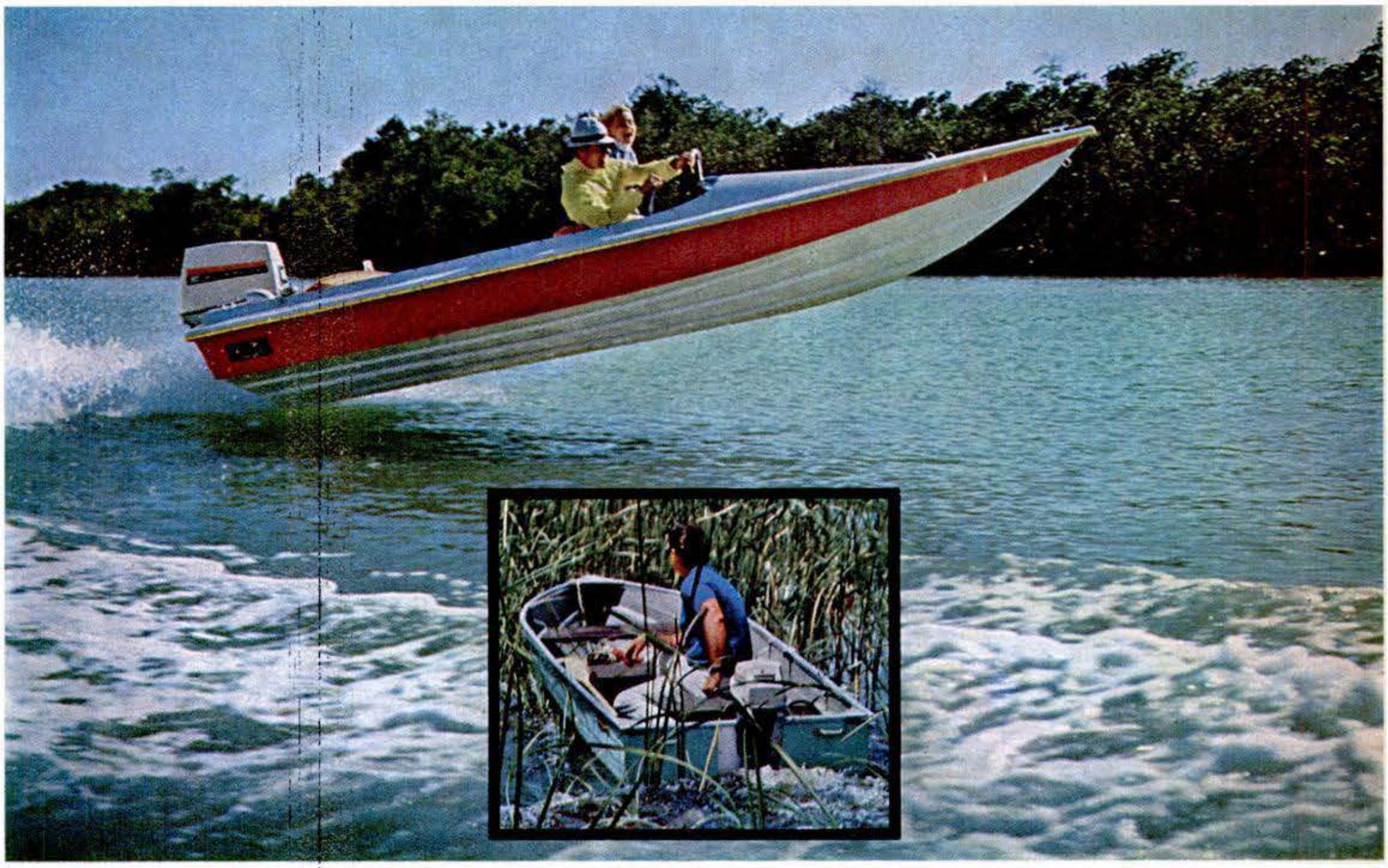
EVINRUDE '70



power for the performance generation

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*Patent applied for.

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There are new 50 mph mini-V-4's — dramatically shorter and smaller — the quickest, strongest Evinrudes ever built. High performance motors that sit so low on the boat and run so quietly you scarcely know they're there.

There are *New Generation* Evinrudes for every generation — from the tiny 20 lb. Mate to the mighty 115 hp Starflite V-4.

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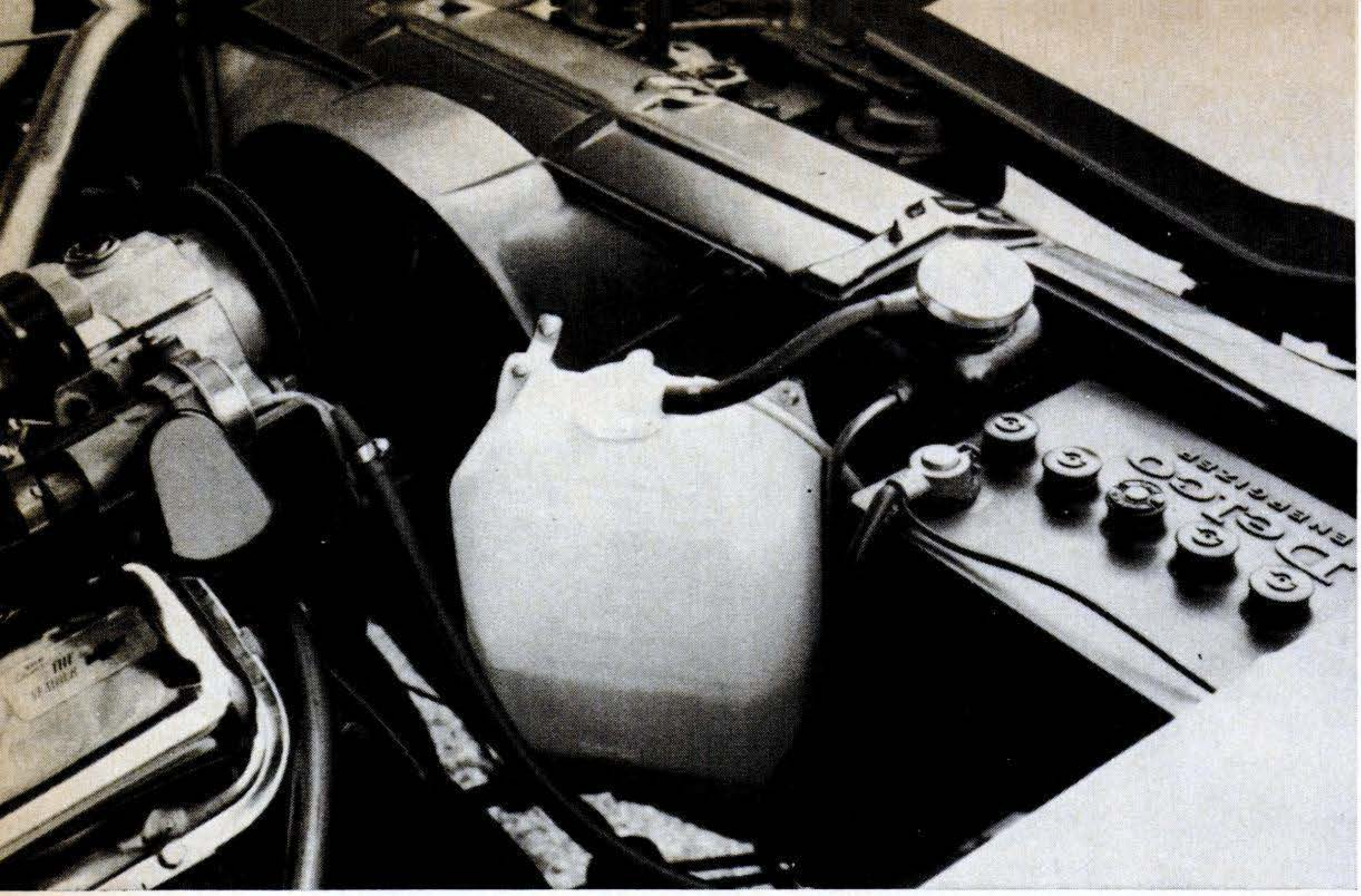


The reservoir is connected to the pressure cap and prevents loss of your radiator coolant.

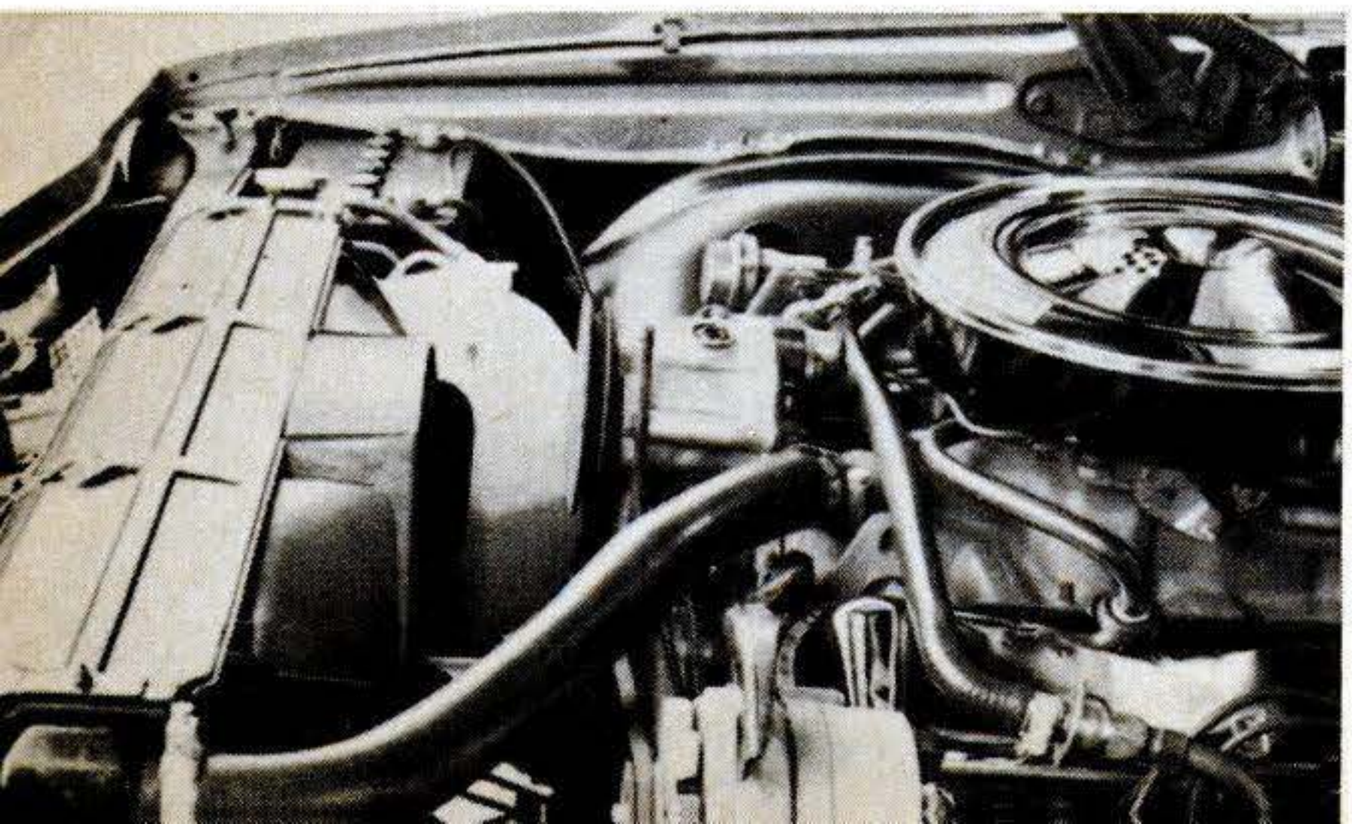
Make Your Own Coolant-Recovery System

By CLYDE J. BAKER

This two-quart expansion tank will cure many overheating problems and stop loss of coolant through the overflow pipe. It prevents foaming and retards rust formation in the cooling system by removing the air (the radiator is sealed off—only the reservoir is vented). You can put the coolant-recovery system on your car for less than $3.

Fit a 1969 Cadillac radiator cap, part number 6410427, listing at $1.75. Cut the overflow pipe, and run a small hose to the bottom of a salvaged windshield-washer-fluid tank. Or use Cadillac's coolant reservoir, part number 1494755, listing at $2.35. With the engine cold, fill the radiator to the top, fit the pressure cap, and connect the vent hose to the top of the reservoir. Add enough coolant in the reservoir to make sure the end of the vent hose is submerged. As the coolant is heated and expands, the excess will be vented into the reservoir. When the engine cools off, it will be drawn back into the radiator. If all coolant is drained from the reservoir, add fresh coolant to the reservoir—never to the radiator. Adding antifreeze works the same—just pour it into the reservoir.

Space for the reservoir is available close to the radiator on most cars. Installation level is not critical, and the whole job is relatively simple.



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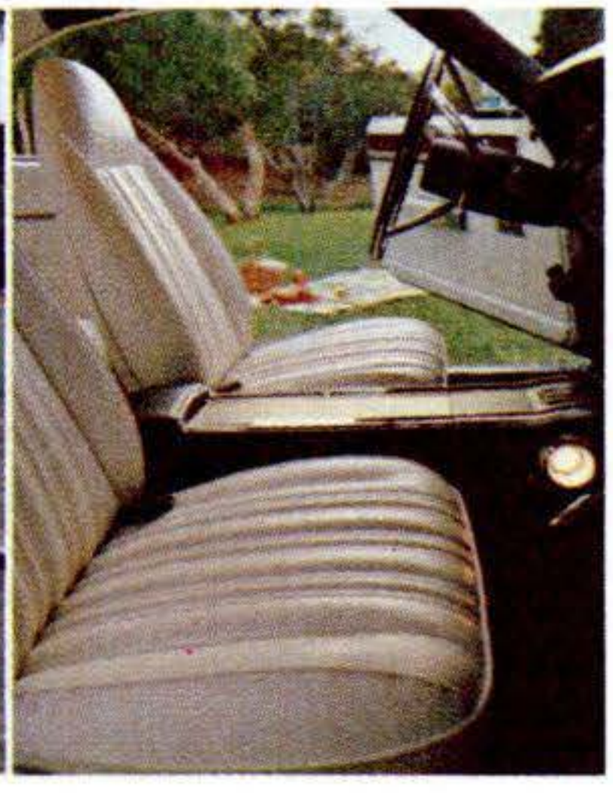
A good low-priced car is hard to find. A roomy (six-adult-capacity), low-priced car is even harder. Enter the 1970 Dodge Coronet. Very big for its price. Choice of 17 lively models, running all the way up to the sporty bucket-seated 500, shown above. Besides all-new looks you can be proud of, the Dodge Coronet 500 has an all-vinyl interior, carpeting, three-spoke steering wheel, a 318 V8, and more than 20 reassuring safety features. And all for a price that will drive you right out of the high-rent district. Without sacrificing all the extras you want. 1970 Dodge Coronet—a brand-new, good-old, low-priced car.



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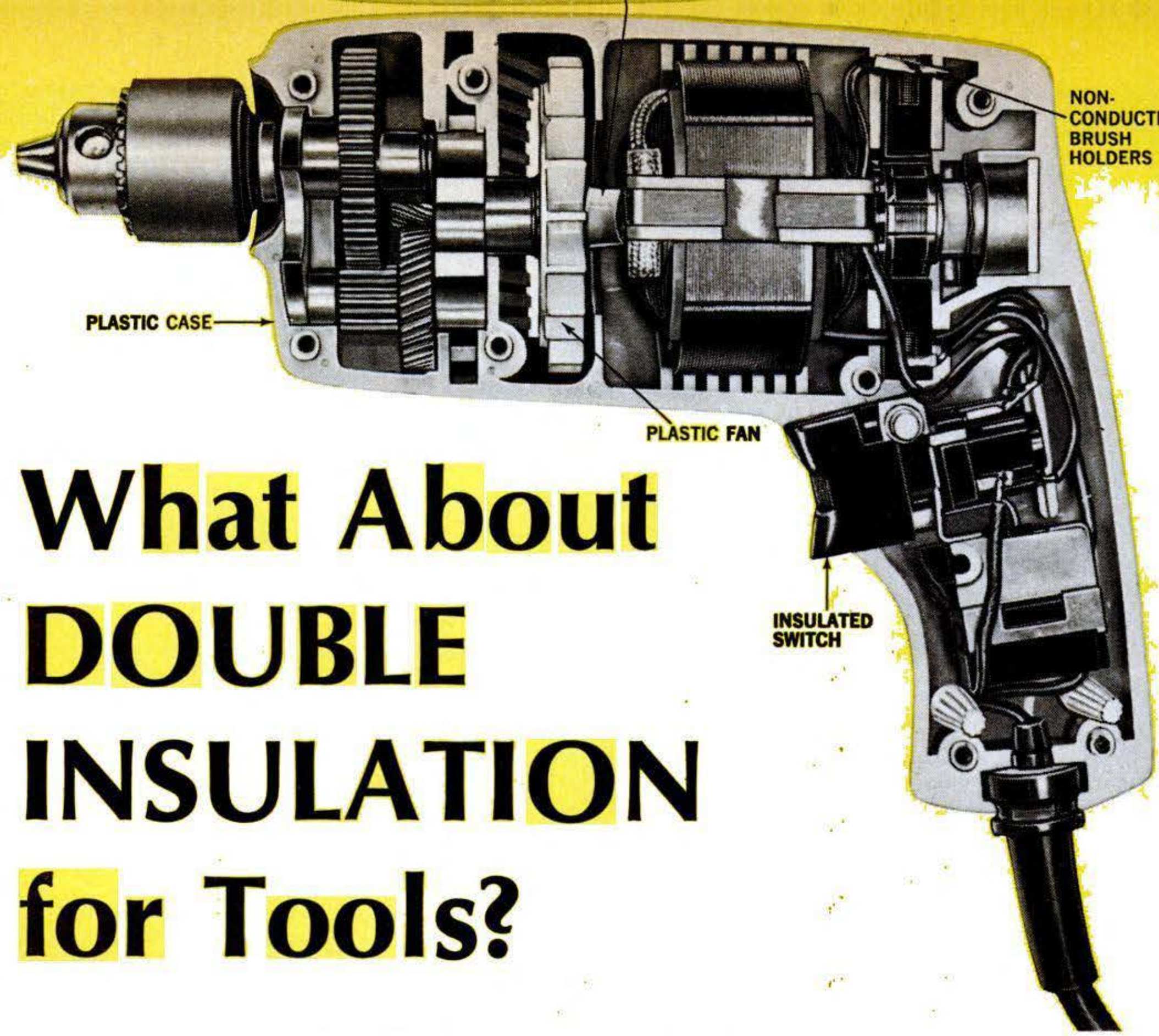

What About DOUBLE INSULATION for Tools?

Safety barriers that would help keep dangerous electrical charge from reaching you are noted in cutaway drawing of typical ¼" double-insulated drill now on market. Sketch is from Rockwell Mfg. Co.

Does it have merit? Should you pay extra for it if necessary? Here are expert answers

By JACKSON HAND

I have just finished a solid week of conferences with leading portable-electric-tool manufacturers, chasing down facts about one of the least understood developments ever to hit the tool market: *double insulation.* I'd heard of DI (as they call it) before this, of course, but checked it off lazily in my mind as perhaps meaning "twice as thick" or maybe insulated against both electricity and heat. Whatever it was, it didn't seem to make much difference to me because all my electric tools (some of them 20 years old) were working fine.

Then one day I was looking at a hedge trimmer at the hardware store and I noticed the plug had only two prongs, instead of the three to which I'd been accustomed. I asked the clerk why and he pointed to the specification plate, on which the "double insulated" designation appeared. "With double insulation you only need two," he said.

"Standing in wet grass with an electric tool in your sweaty hands you only need two?" I demanded.

"That's what they say," he said. So I determined to find out what it is that they really say. One interview led to another until I had finally covered Black & Decker, Montgomery-Ward, Millers Falls, Rockwell, Sears, Shopmate, Skil, Stanley, and Wen. Starting right at the beginning, here are some of the questions I asked, and the answers I got.

What, exactly, is "double insulation"?

Actually, a better name for it would be "safety insulation," since the total pur-

Continued

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Many types of tools are now double insulated

Double insulation has spread gradually to just about all types of tools for home shops since Millers Falls introduced the first DI drill in 1960. A representative grouping of tools you now can buy is shown here. Most recent tool to get double insulation is a portable circular saw. Millers Falls, Rockwell, Skil now offer such saws. Shopmate also has a new DI tool line.

Stanley 3/8" drill

Rockwell saber saw

pose of the "double" aspect is to provide safety for the user. A double-insulated tool has the normal electrical insulation required to make it function. In addition, all electrical parts such as motor, brushes, switches, speed, controls, etc., are surrounded by insulation *or by proper air space*. If something should go wrong with the basic insulation, electricity could not "leak" to the handle or housing. A fuse might blow, but you would get no shock.

Not even with sweaty hands, wet grass?

Nope.

Isn't the same thing true of three-prong wiring?

Yes, it is true, provided the third prong—i.e., the grounding prong—is actually grounded. This is often not the case, for a number of reasons. When the ground wire is not connected, *you* become a grounding medium. The result could range from "ouch" to "requiescat in pace."

How does three-prong work, when it does?

In a basic oversimplification, an electrical circuit moves from the source along one wire and back along another. Actually, it is just as effective for electrical current to return to its source through the ground—literally.

Thus, a two-hole outlet has one side that is "hot" and one that is "ground." You could light up a circuit tester by plugging one wire into the hot side of the outlet and touching the other side to a grounded water pipe.

A three-hole outlet has a deliberate and effective ground into which the third prong goes. The third wire in the cord is fastened to the housing of the tool—the part you hold in your hand. If there is a "short" (ground fault) in the tool, bringing electricity to the housing, it is dissipated through the third wire—not through you, since the wire is a better conductor than you are.

Why isn't this 100 per cent safe?

It is, except for a few very important ifs.

1. Perhaps half the portable-tool owners in the country have become fed up with the nuisance any three-prong plug can be when it's in an environment of two-hole outlets. Not many older homes have three-wire outlets. Even if you wire your shop for three-prong, you may take the electric tool where there are only two-holers. Use the adapter—the "cheater"? What a nuisance! Lose the adapter? Okay—off with that lousy third prong and take your chances.

2. Not all owners of three-prong tools are also owners of three-wire extension cords. Some of the slick new cords (two-wire) have flat female ends. The third prong slips by easily, sticking out in the air, making it easy to cheat.

3. There is always a chance that the third hole of a three-holer may not actually be connected to ground.

Continued

Millers Falls saw

Black & Decker variable-speed drill

Skil orbital sander

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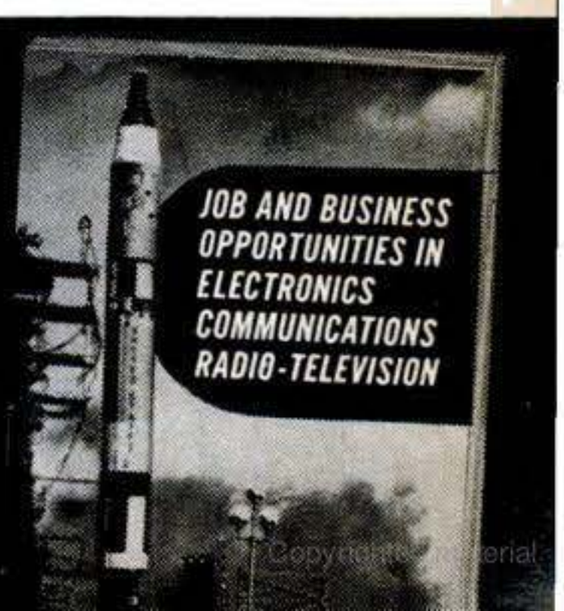

Strong proponents of the DI principle often mention one additional shortcoming of the three-prong system. It goes like this—and it's possible, despite your instant tendency to say "Oh, come, now."

You are working with—let's say—an electric drill, putting up some drapery hardware in the living room. It's a three-prong cord. The outlet is a three-holer, connected solidly all the way to mother earth. Nothing could be safer.

But—standing there with the drill in your hand, *you are grounded* as effectively as any electrician could ground you, because the grounding wire is fastened to the tool housing you are holding. Okay?

There is a bridge lamp in your way and you grab it with your free hand, to move it. Pow! It so happens that the bridge lamp with its metal standard has been "hot" for years, but you didn't know it; whenever you touched it before, you were insulated by the wooden floor, the rug and pad, and maybe rubber-soled shoes.

DI also protects you in the yard

Some makers of home-shop tools have also extended double insulation to their lawn and garden tools. Included are the two shown below—Black & Decker's electric mower (top) and Shopmate's shrub and hedge trimmer. Edger/trimmers also come double insulated.

However, holding that three-prong drill in your hand you are grounded—and you can quickly be killed.

Remote possibility? Yes, but the casualty records show it has happened, and the hot item causing the problem can be a toaster, refrigerator, or any other rig that's normally two-wire.

Doesn't all this make the three-prong system look bad?

Not at all. But it does make a high percentage of users look bad. When the three-prong tool is properly used, properly grounded in a three-hole outlet, it is just as safe as an electric tool can be. It takes an unlikely combination of conditions to give trouble.

Then why bother with this double insulation?

Because, to put it bluntly, you can't make a stupid jerk out of yourself with a DI tool. The safety is built into the body of the tool, not just at the end of the cord. V.C. Giffen, a Millers Falls vice-president, told me:

"People are unrealistic. They rationalize that 'it can't happen to me' as they bypass or thwart the safety feature of the third prong. Manufacturers who include DI tools in their lines are making an effort to take the matter out of the hands of the user. Since the tool plugs in anywhere, it eliminates the temptation to outwit outwittable safety devices."

This has been more fully appreciated in Europe and elsewhere abroad, where double insulation has been in use for as long as 25 years—and where standard household current is often 220 volts. In fact, it is close to national law in some countries. The accident rate among DI tool users has been so tiny in Europe that, in 1960 Millers Falls brought the idea to America and produced the first DI tool in this country. Double insulation has now gained the endorsement of the National Electrical Code and the Underwriters Laboratory.

Then DI makes a tool absolutely safe?

None of the tool manufacturers I talked to used the word "absolutely." Some of them—those who do not see DI as a panacea—emphasize that such tools are not absolutely safe. It is true, however, that it takes a fair stretch of credibility to set up a failure situation. . .

1. Something could go wrong with the

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secondary insulation, making the tool no better than old two-prong models.

2. Then, if something also went wrong with the primary insulation, there could be trouble. However, with DI tools, both systems would have to fail at the same time to produce total failure. And, the way they are engineered, types of insulation are employed in each which are not subject to the same stresses.

3. On top of this, the typical DI tool has a nonconductive plastic housing or handle or both. On many tools intended for home-owner use, everything is plastic except the chuck—or the blade—or whatever. To make electrical contact you'd have to take hold of this moving part. On heavy-duty tools, part of the housing (that which encases gears and other hard-working internal parts) is often metal, and it is quite possible that the user might grip the metal area, handling the outfit in a normal manner.

4. To match the bridge-lamp hypothesis, there is an equally outside-chance situation with DI tools. Suppose you were drilling into a wall and the drill should hit the hot side of an unsuspected electrical run. For some reason, the drill gets stuck. You reach around in front of the plastic housing to pull it free, and your hand touches that shiny metal chuck. If you happened to be standing on a good ground, you could get a real jolt from the hidden electrical wire.

Thus, the difference in shockproofness between DI and three-prong properly used is a standoff. Three-prong suffers, however, because of the chance—even the likelihood—that the safety feature will be voided in one way or another, sometimes by accident, sometimes willfully.

Price breaker! Double-insulated home-shop tools in the past have usually brought a premium price. This Rockwell ¼" drill may represent a change. Formerly selling for $14.99, it's currently priced at $9.99.

Why, then, don't we have DI in all tools?

The industry leaders I talked to agreed 100 per cent on the reasons why all portable electric tools are not double-insulated. Richard Cooper, general marketing manager at Stanley, listed four:

1. The consumer has not indicated a willingness to pay any additional cost for a double-insulated tool.

2. The consumer has shown a definite resistance to the plastic housings which are all but essential to proper DI.

3. There has been very little interest—demand—among consumers for DI. Some toolmen say the consumer resists it because he doesn't know what it is.

4. Manufacturers, who must be allowed to operate at a profit, point out that it costs a lot of money to switch a tool from three-prong to DI, and few of them are willing to throw out the machinery for making metal tools and replace it with machinery for making plastic tools, if they are then going to find it necessary to spend money selling the consumer on the plastic, while preference seems to be for metal-housed tools.

What's wrong with plastic tool bodies?

Absolutely nothing. Some makers are working on fiberglass reinforcing of polycarbonates and other plastics, to give even greater strength. Plastics are considered warmer, easier to hold, lighter in weight, more colorful. Some manufacturers guarantee plastic for life against damage from any possible cause.

On heavy-duty tools (aimed at industrial and commercial users) plastics are not yet ready for such assignments as gearboxes. Stresses and temperature changes might destroy gear alignment. However, Stanley, for example, uses plastics for the parts of a heavy-duty DI drill and a DI impact tool which you'd most likely touch during operation. Heavy-stress parts of these two Stanley portable tools are still made of metal.

Nevertheless, consumer resistance to plastic, unfounded as it may be, has slowed down introduction of DI tools, and in some cases blocked it entirely. For instance, Wen told me they do not, in view of current conditions, plan to come out with DI until they have perfected a method of do-

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ing it on tools with metal bodies. They are at work on such a tool and believe that DI with metal housings is feasible and foreseeable.

What is the Underwriter Laboratory attude toward DI?

The stand of UL, as stated by its chief electrical engineer, W. A. Farquhar, is that DI is better than three-prong for two basic reasons. First, there is no simple way for a user to check the effectiveness of the third prong. Second, it takes two unrelated, simultaneous failures to produce a dangerous DI tool.

Although UL is interested primarily in electrical safety, there are certain UL specifications that affect overall tool quality, too. Some of these requirements exceed the quality demands set up for three-prongers. Among these are prolonged operation under heavy load conditions, resistance to failure under heavy impact such as falling from considerable height onto a concrete floor. In one test, a tool is deliberately burned out by overloading, then subjected to a 1,000-volt test.

What are the basic techniques used in double insulation?

They vary from plant to plant. Millers Falls first introduced DI. So let's take this company as an example. Live components of a drill are field, armature, brushes, commutator, switch, and the wires. These elements must be insulated from the housing, gear train, and chuck, to prevent danger in case of electrical failure inside the tool.

Millers Falls first coats the drive shaft with aluminum oxide, then grinds it true before applying the armature plates and winding. Thus, the shaft is insulated from the electrical elements. Also, the handle, switch, and openings for the wire are insulated. Finally, field, brushes, and commutator are encased. The cooling fan, ordinarily metal, is plastic. In addition, certain spaces are increased to reduce chances of current leaping a gap and causing trouble.

With all this, plus a plastic housing, a double-insulated tool is pretty well engineered against all chance of an interior short getting through to the hands holding the tool.

How great are the chances of getting badly hurt, either way?

If you are standing in water or wet grass, touching a waterpipe, or otherwise well connected to earth, it doesn't take much juice to cause serious harm. Things are complicated by the physiological fact that an electric impulse may cause muscles to contract, and you clutch the tool instead of flinging it.

The first tingle of electricity you can feel is about 0.2 milliamperes. With better conductivity—such as wet hands—that amperage could jump two milliamperes. That's enough to make you jerk away, drop a tool, or even lose your footing on a ladder. A little more current—between five and 10 milliamperes—might cause you to grip the tool in a muscle spasm. The prolonged contact could be deadly. Wet hands, wet feet, or a wet floor can boost the current another tenfold, and at 50 or 100 milliamperes (not enough to light a flashlight bulb) a healthy man would last only a second or two. That is the statement of the National Testing Laboratories. For people less than healthy, for women, and for children, the lethal threshold is much lower.

As you can see, the degree of danger varies, but the kind of danger is such that you shouldn't ignore the possibility. The hard thing to make people pay any attention to is the fact that the ungrounded tool doesn't give you that little tingle as a warning, so that you can let go. Instead, the full jolt hits you, and it could be too late right then and there for any further consideration of this or any other of life's problems.

What is the trend in the industry?

No manufacturer to date makes all tools with double insulation, but most major producers include them in their lines.

Usually, DI tools are in the higher price brackets. But there is little question in the industry mind that this cost premium is tending to disappear.

Looking to the future, Frank Lucier, vice-president and general manager of U. S. operations for Black & Decker, told me:

"If double insulation is a way to make tools safer, and if manufacturers can develop the means of bringing this additional safety to the public in all tools without an unacceptable premium in cost, I am sure the power-tool industry will do it—that the public will accept it. And—I am sure this will happen." PS

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GO with the best!

BEAUTIFUL

Distinctive styling and design refinements make the all-new Big "A" the one to go with. Nine beautiful models with sleek, graceful lines . . . flawless construction and finish. And Alouette is first with safety features. New emergency kit with spare plug, drive belt, pull cord, light bulb. New permanently mounted instrument dashboard eliminates short circuits. New caster and camber steering banks skis for safer turning. New one-piece steel underbody welded to steel chassis for maximum strength and safety. New safety-design seat and backrest for non-slip support. Good reasons to go Alouette.

EXCITING

The powerful Big "A" is a top performer in every way . . . and you can trust the rugged, sure-footed Alouette anywhere. Low center of gravity and wider track skis give better traction and stability. Alouette's new variable speed, cam-operated torque converter transmission is electronically dynamically balanced for safe, smoothly controlled power. From the lively 277 c.c. to the luxury widetrack Big Bird and new high-performance competition models, Alouette is way out front. So if it's exciting action you want, go with the best. Go see your Alouette dealer.

1970

Alouette®

The Reliable One

FEATHERWEIGHT CORPORATION, MONTREAL, CANADA

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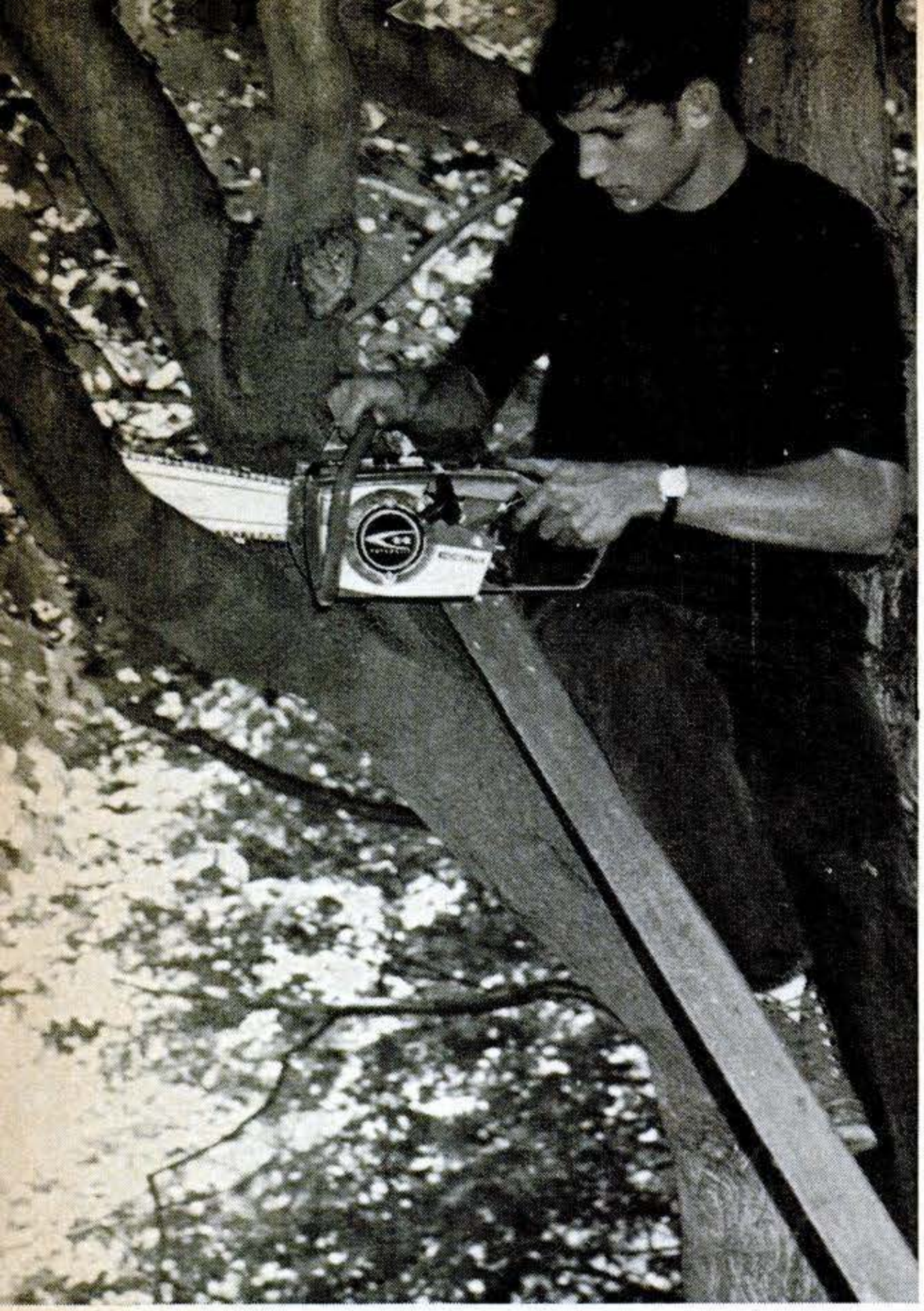

PERSONAL-USE REPORT

New Mini Chain Saw Does Big Jobs in Tight Spots

By JACKSON HAND

When I came home carrying a new Homelite E-Z Automatic, my wiseacre 17-year-old said: "Hey, Dad's bought an electric toothbrush!" As a reward for his wit, I elected him to help me try out the new saw.

In less than two minutes he dropped three eight-inch maples crowding our woodlot, then scrambled up a ladder to lop dead branches off a remaining tree. Between us, we've decided that the E-Z

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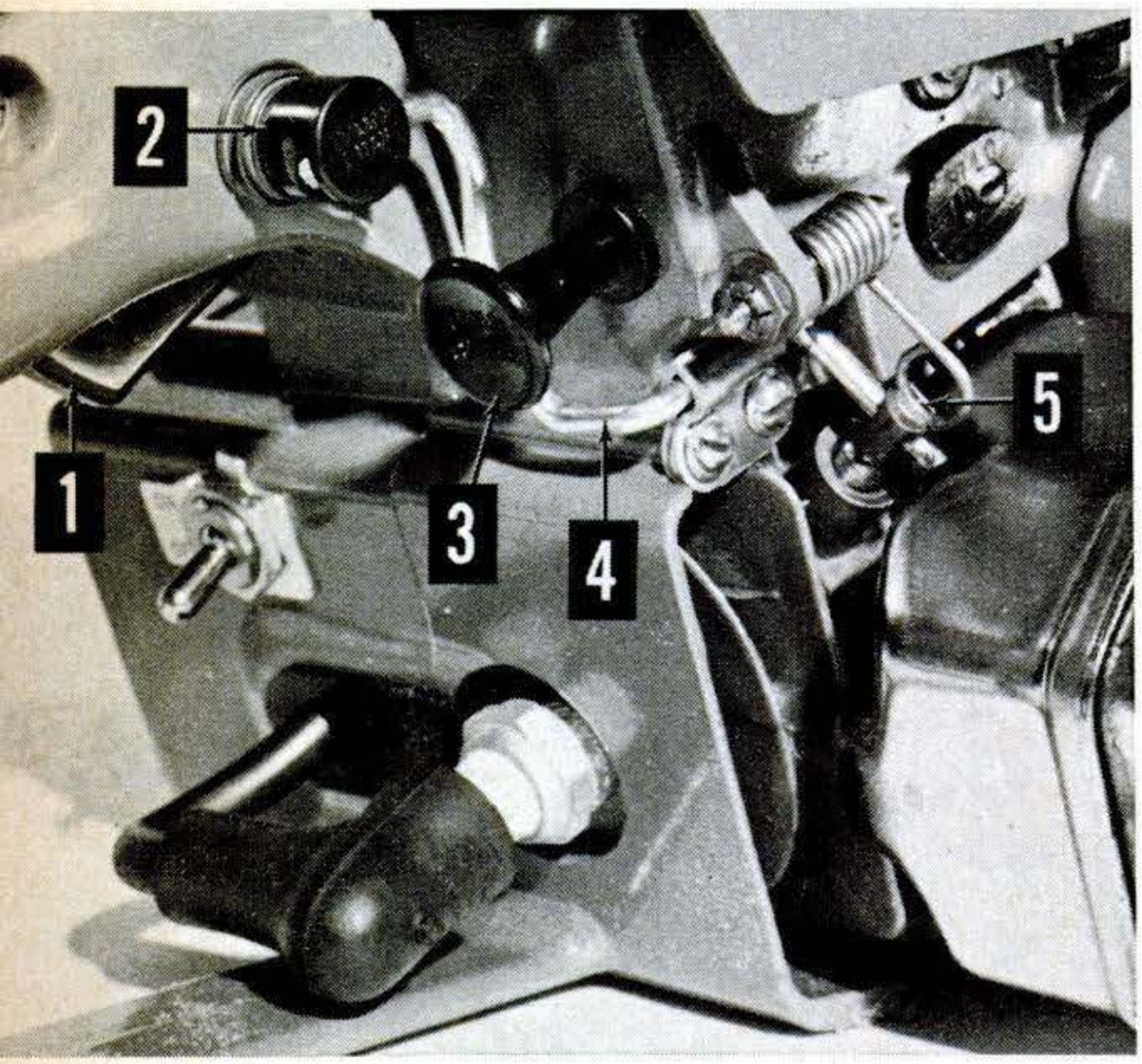

Steps to easy starting: with switch on, depress trigger (1), push latch (2), then release trigger. Pull choke (3). Latch is coupled by bent rod (4) to compression release (5). Tug starting cord; when the engine starts, flick trigger to release latch.

Compact engine size is indicated by this miniature piston. Its single ring is an adaptation of the Head Land ring, introduced in last year's cars. Ring expands under compression to seal the combustion chamber, with minimum friction against cylinder wall.

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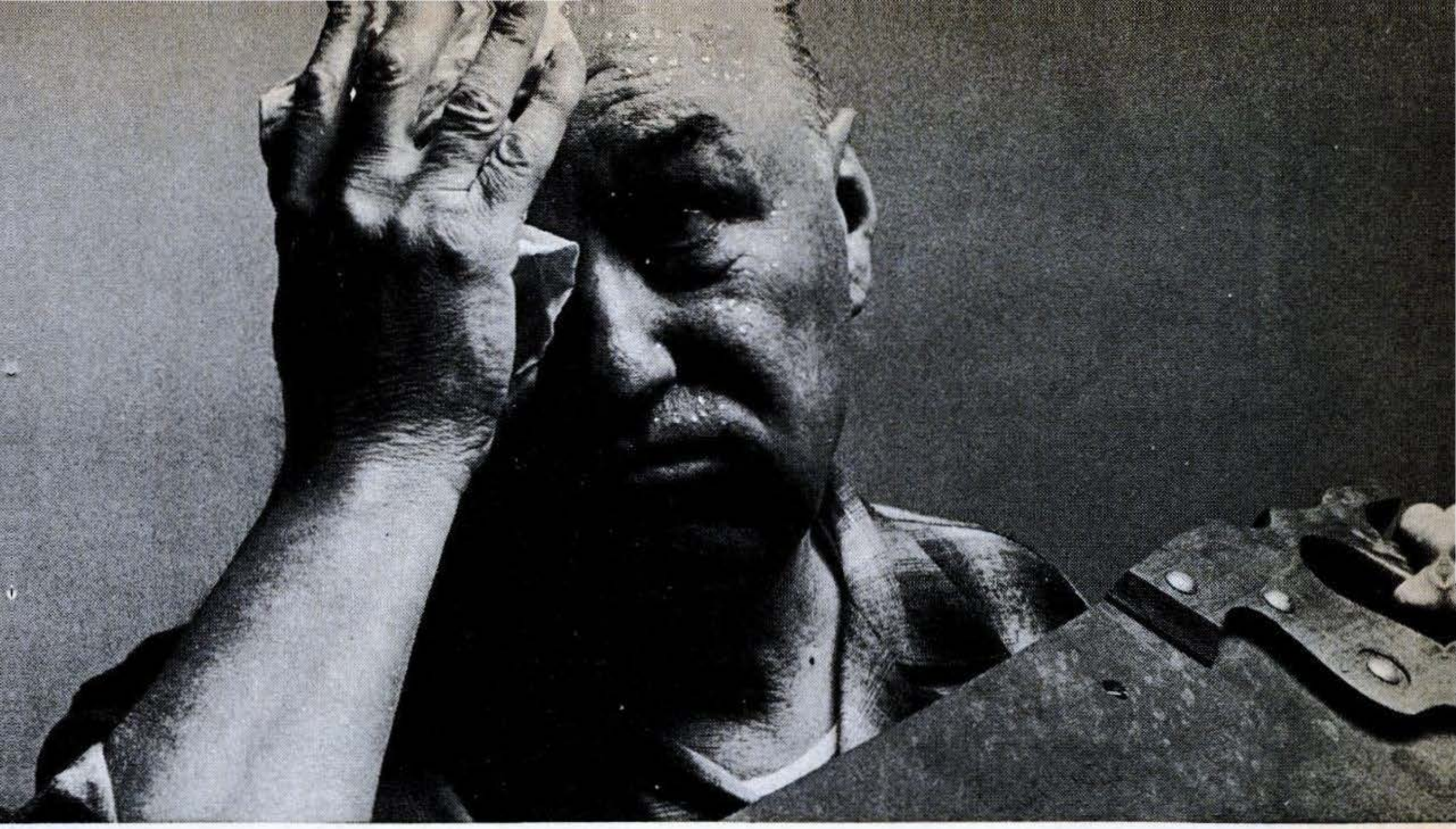

If you're not working with tools coated with TEFLON-S*

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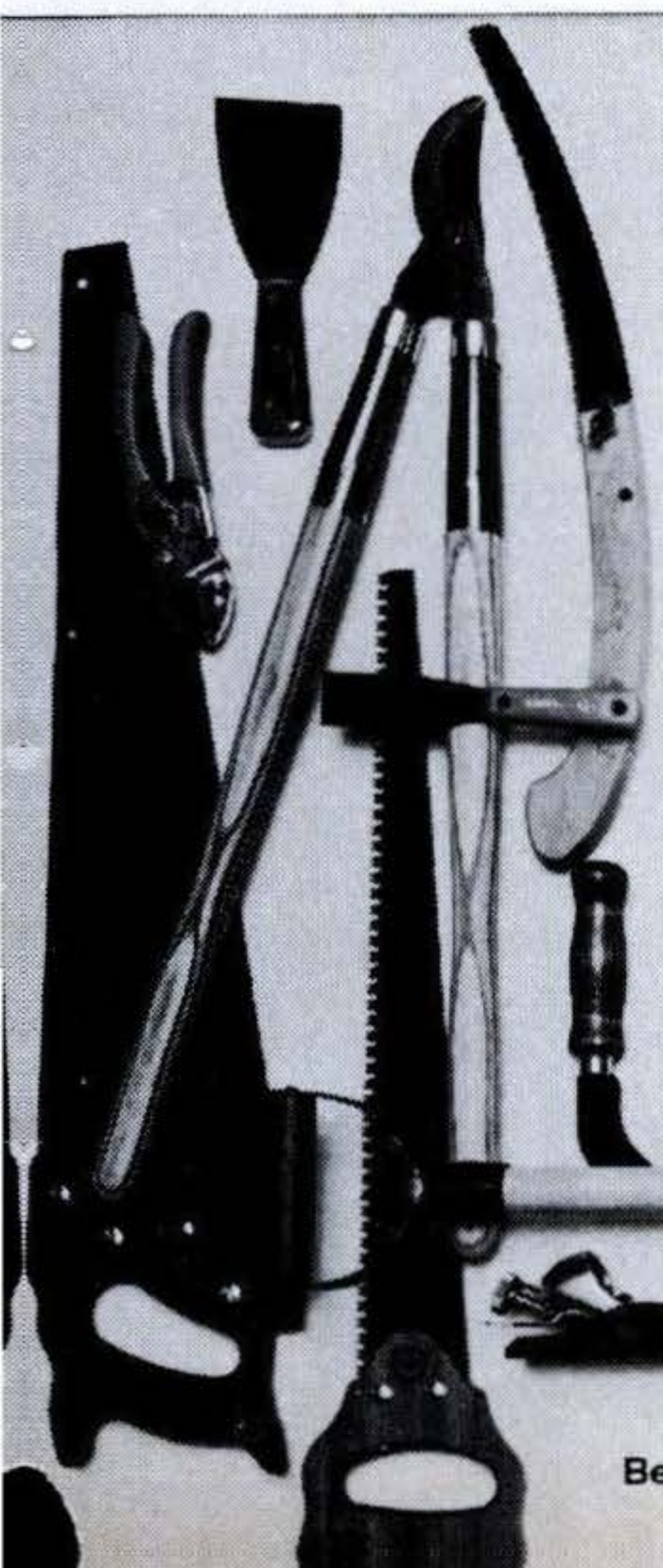
self lubricating, no stick, easy clean, no rust

you're working much too hard.



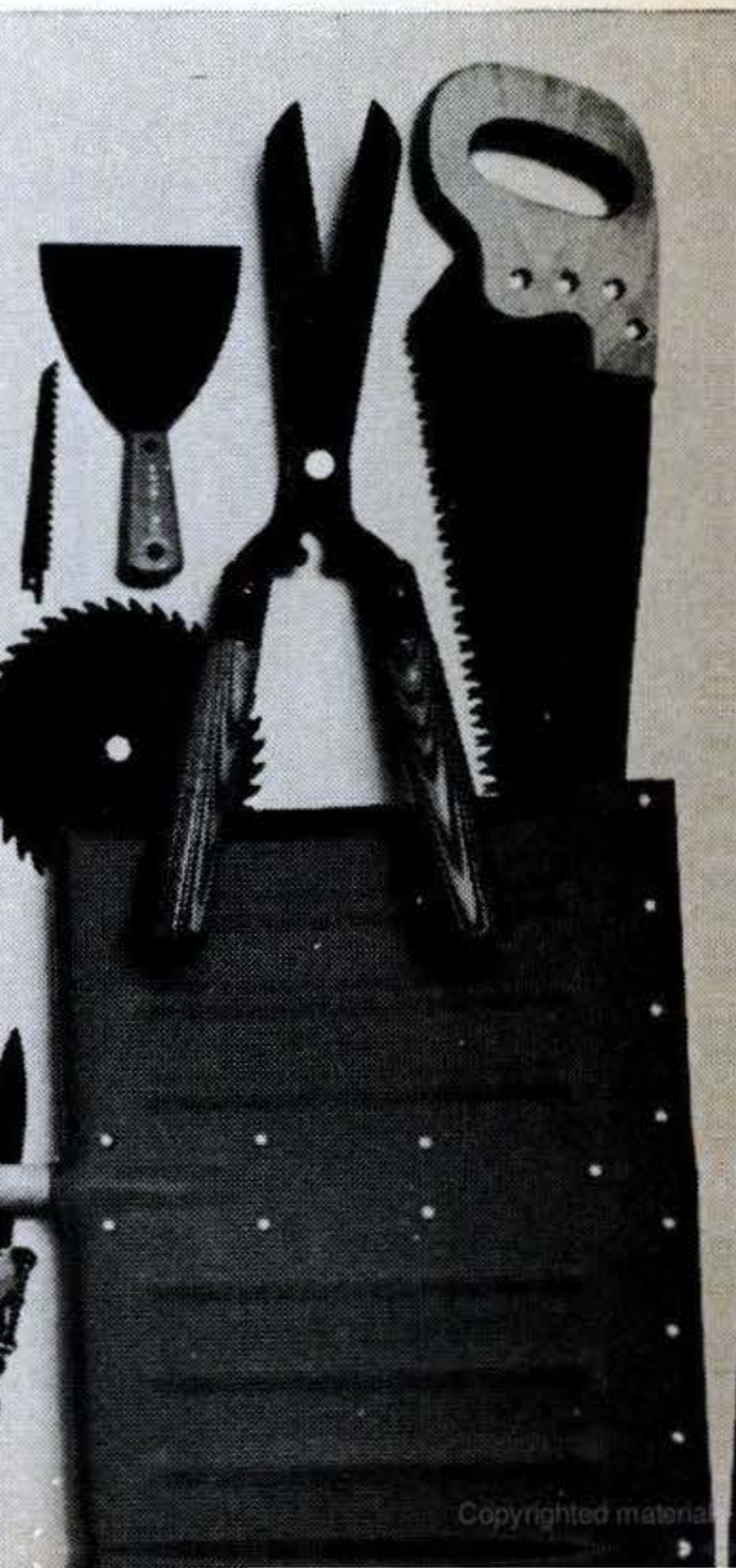
The friction-free magic of TEFLON-S means handsaws don't bind, putty knives don't drag, pruning shears don't gum up, snow shovels don't let ice and snow build up and power saw blades last longer and cut cleaner. They all clean up like a snap, and resist rusting.

TEFLON-S lends the same ease to grass clippers, anvil pruners, hedge trimmers, wall scrapers—and who knows what next?

When you see the TEFLON-S Quality Seal on a tool you know that the coating definitely contributes to its performance, and that the coating meets Du Pont's tough standards. You can have confidence in it even before you use it.

Look for the TEFLON-S seal on tools in your hardware store.

*Reg. U.S. Pat. Off. for Du Pont's non-stick finishes.



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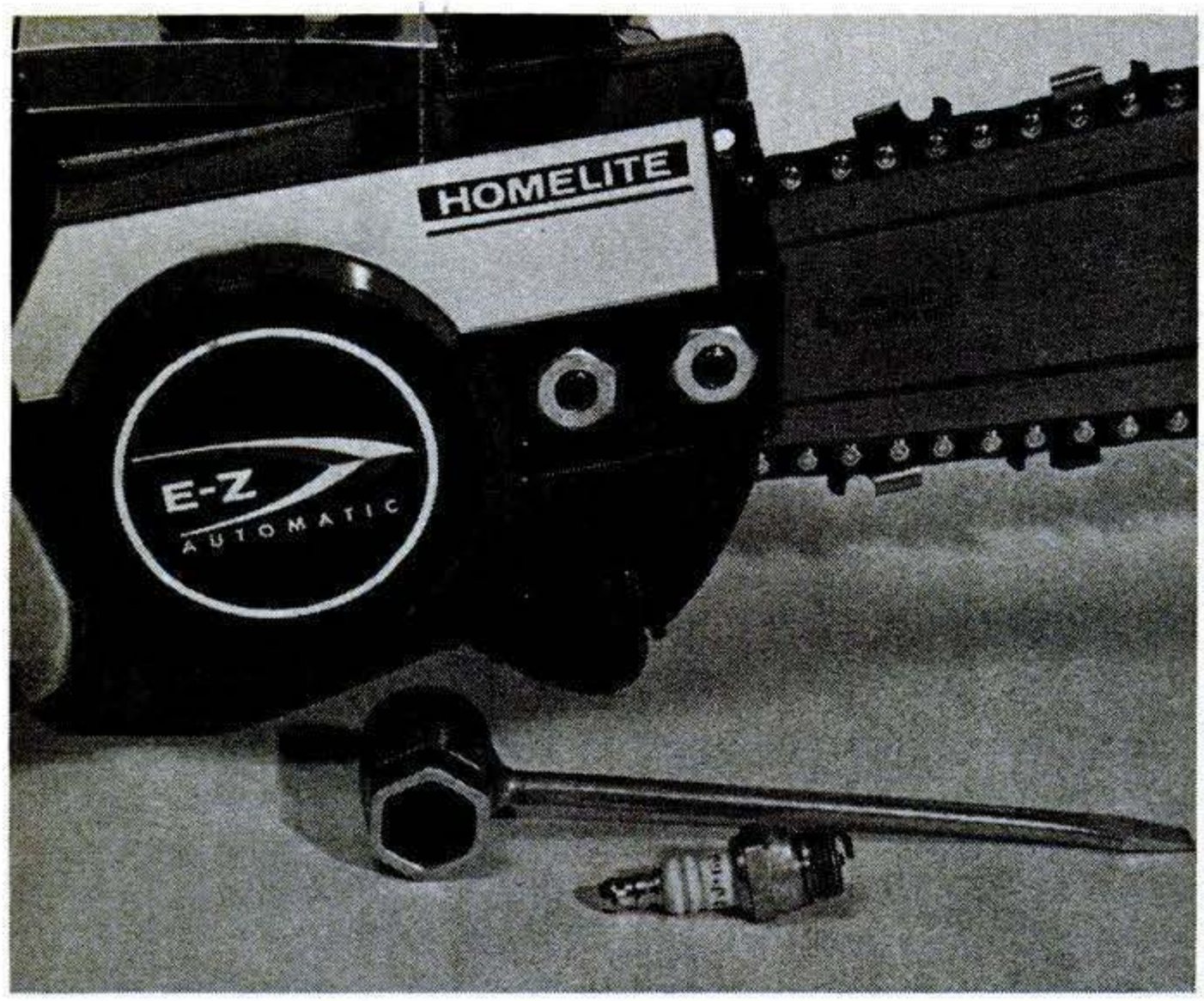
Stream of sawdust down and away through specially designed chute cuts down on chip accumulation, making for easier maintenance. A series of cuts through eight-inch maple averaged under 10 seconds.



Shrewd design detail: Spark-plug wrench also fits chain-adjustment nuts shown above. Thus two most-common upkeep chores are done with single combination socket-wrench/screwdriver in foreground.

—despite its "toothbrush" size—is a solid tool on the job. And it boasts a combination of features I've missed on other saws:

- It has a gear-driven, clog-proof automatic chain oiler. You forget oiling, except when the wood is extremely dry—dry enough to absorb the chain oil. Then you push the oiler button.
- The smallness is where it belongs. With the blade set only an inch from the side, you can leave a stump an inch high. The blade width is only 3¾ inches.
- Balance is perfect. You can handle the saw with one hand, between cuts. When you set it down, it heels backward, keeping the blade clear of the ground.
- It's 9½ pounds light (the companion E-Z nonautomatic weighs a pound less) so is an ideal pruning saw, yet its capacity takes it into actual logging jobs.
- Mechanically, the saw is as simple to take apart and reassemble as a nursery-school toy, with tabs and slots and pegs and holes that make it impossible to put it together wrong.

This saw, capable of doing a man's work, operates on 2.3 cubic inches of displacement (2.1 for the nonautomatic). It's fingertip-easy to start, with a compression release and throttle holder. And it comes as close to being quiet as any chain saw I've heard. It runs a half hour on a filling of gas—and in that half hour it does a weekend of work.

It isn't the lightest or least expensive super-lightweight on the market, but the combination of features I've outlined rates it high in my book. PS

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Take it from people who know, ski-doo is the one with the winning personality!

Last winter, Ski-Doo won more races than all other snowmobiles combined. And set a world speed record doing it!

If a snowmobile can take on all competitors in every class and win race after race, it has to be good. But being good on the track isn't good enough. Once again, we've gone all out, so you can go one better on the trail, too.

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Better selection. For 1970, we offer five Ski-Doo series, each with a totally different personality. If it's luxury you're after, we have it. If it's economy, we have a Ski-Doo so low-priced, many people are buying two.

If you want the number one choice in snowmobiles, in high fashion winter sportswear and accessories, see your Ski-Doo dealer. He'll show you the 1970 reasons why you go one better when you go Ski-Doo.

o one better go ski-doo

North America's number one snowmobile

*T.M. Bombardier Ltd.

Your Guide to Tin Snips

[Continued from page 176]

metal to coil away. They're great for downspouts and heating ducts.

Bulldog snips. These are used quite often for notching and nibbling and general, heavy-duty work. You're unlikely to find them in an average hardware store. They have long handles and short jaws and this accounts for the power. A common type might be about 16 inches long and have a force ratio of 15:1. Bear down with about 100 pounds of pressure on the handles and you'll get a cutting force of 1,500 pounds.

Curved-blade snips and the similar, hawk-bill snips are specials for cutting circles and arcs—the hawk bill with its offset handles and slim, curved blades being especially good for tight places.

A fellow interested in wrought-iron work should know about bench shears. The simple-lever type resembles over-long straight snips and, like the bulldog, are proved for a greater force ratio. The compound lever will cut 12-gauge sheet iron. Both have a right-angle bend at the end of the lower handle to fit a hole in a bench top. Force is exerted by bearing down on the top handle, which has a similar end bend to serve as a stop.

Using them correctly. Manufacturers figure that the average man can exert a grip force of 75 to 100 pounds and they design snips accordingly. Trying to get more oomph at the blade end by extending the handles with pipe or by banging them with a hammer is a bad scene. If you have consistent trouble cutting sheet metal you work with, get a pair of snips with longer handles.

Greatest force ratio is closest to the pivot. So cutting near the throat of the blades is easiest and gives you better control. Full-blade cuts are not wise for two reasons—the closer to the tips you get, the harder it is to cut, and, cutting to the very tip of the blades causes imperfections in the cut. Maximum cut stroke should be about ¾ the blade length.

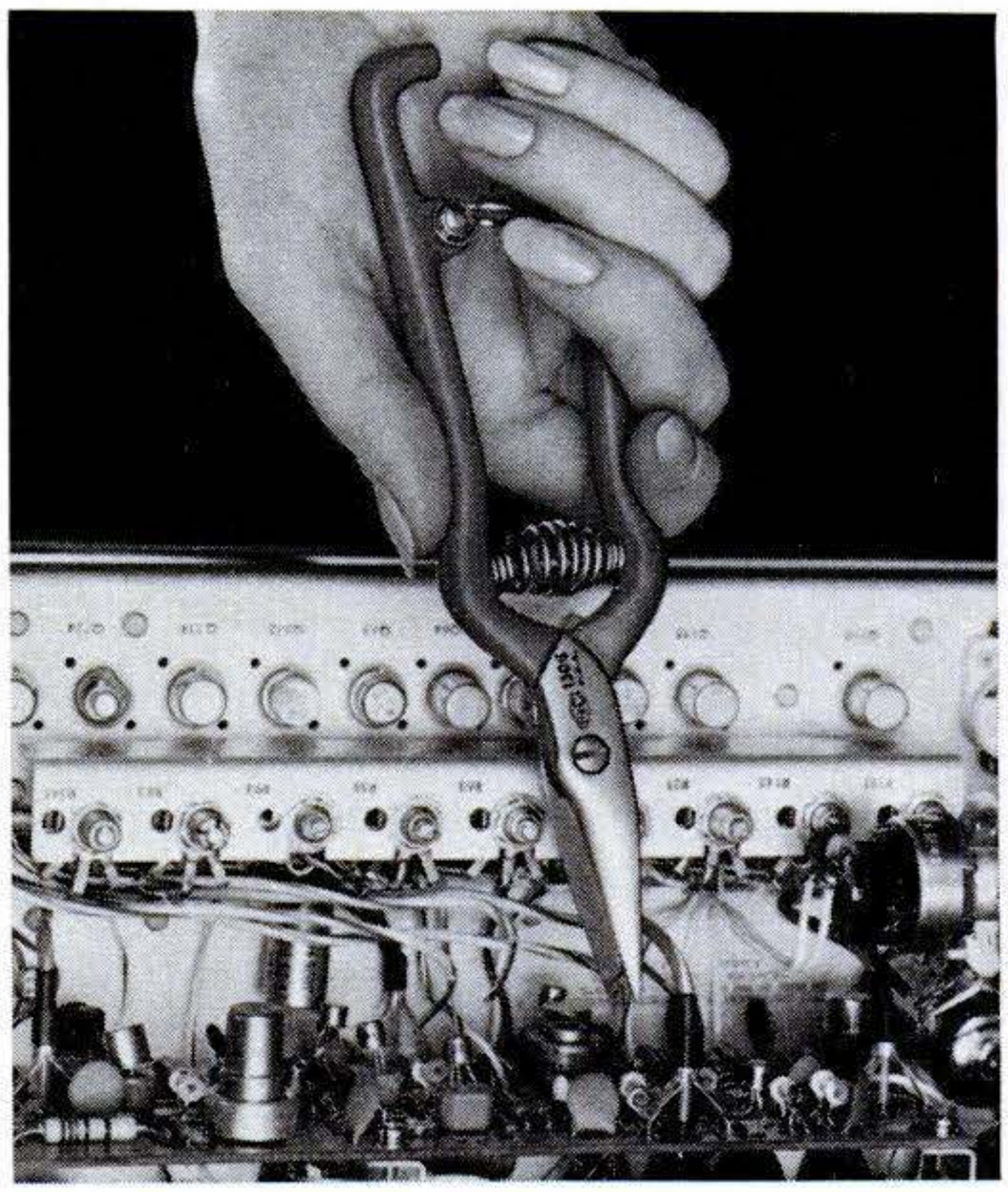
It's okay to rest the lower handle of snips on a bench top and apply pressure to the top handle only. In fact, on large sheets this is one way to ease finger strain and let you put some of your weight into the job. For short cuts in heavy stock, you can grip the lower handle in vise jaws.

For inside cuts that do not permit a lead-in cut from an edge of the stock, drill or punch a starting hole for the tips of the snips; then nibble away until you have enough room to cut. If possible, enlarge the starting hole with smaller snips. Don't try to make right-angle turns; instead, execute the corner by making two cuts that will meet.

Although we haven't done so in any of the photos, it's a good shop practice to wear gloves when cutting metal. Sharp snips create sharp edges and corners.

The care of snips. General rules are simple. Don't use them if you can't make the cut with your own strength. After use, clean the blades and, if you are going to store them, apply a thin coating of machine oil. It's wise, too, to apply a drop of oil at the pivot or screw. If you neglect this and the tools discolor or form some rust, a light rub-down with steel wool or emery will usually restore the original finish.

I know from experience that a good pair of snips, used correctly, will stay sharp almost forever. Should they dull, let a professional get them back into shape, especially if grinding is necessary. Unless you're really good with a grinder you can do more harm than good. PS



Should you use light-duty snips for wire cutting? A lot of us do it, but the practice is open to question. Better restrict their use to the work they're intended for—cutting flexible metal, not tough wire.

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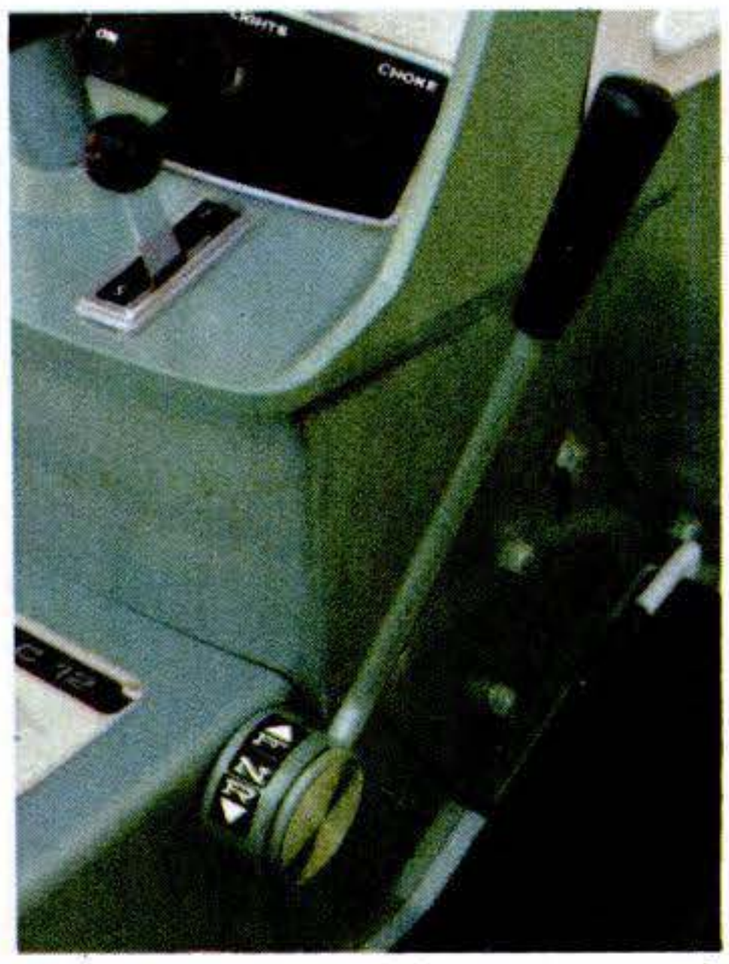

Easy to read grouped instrument panel: Single Lever Control for no-effort tractoring, visual gas gauge, and cigarette lighter.

Be a good guy. Every once in a while let your wife take a ride.

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[Continued from page 161]

so that the breaker points are closed, and also eliminates the possibility of false test readings.

Make sure all accessories are off. When you turn the ignition on (without cranking engine), the meter should read no more than 0.5 volts. Test the ignition switch by turning it off and on several times. The reading should be the same each time. Test all ignition primary wires for tightness by moving them while watching for a change in the meter reading with ignition switch on.

If meter readings exceed the specified maximum, you have loose or corroded connections, undersized or faulty wiring, or damaged ignition-switch contacts. Isolate the point of high resistance by placing the test leads across each connection and wire in turn. Readings should be zero. Across any one wire, the reading should be proportionate to its length, compared to length and allowable voltage drop of the entire circuit.

Test five. This one checks the primary circuit's insulation. If defective, leakage may be so gradual that it can't be detected on a car's charge indicator. Electrolyte, moisture, or dirt on the cell covers provides an electrical path for current and usually results in continuous battery discharge. A 12-volt battery is more susceptible to this energy drain than a six-volt one.

To check for battery leakage, set the switch on normal and connect the (−) lead to the battery's negative post. Move the positive probe around the battery's top (don't touch cell-connecting straps or positive battery post; avoid excessive pressure—the probe might puncture the surface sealant). As you depress the ÷10 button, watch the meter. Any deflection indicates external energy loss.

The cure: remove the battery and clean it thoroughly with a solution of baking soda or ammonia. Also clean the cable connections. Dry thoroughly and reinstall in a full state of charge.

Test six. To check for leakage in the primary circuits, disconnect the ground strap from the battery's negative post. Set the switch to normal and run the meter's (−) lead to the post, the (+) lead to the strap. Make sure all accessories and lights are switched off. If the car has an electric clock, touch battery cable to battery post just prior to the test to rewind the clock—or leave it disconnected if of the continuous type.

If the meter reads zero, no leakage exists. If there's a slight reading, push the ÷ button to see if it persists.

To spot leakage (an incomplete short), remove the hot lead from each of the following components, in the order listed, retesting after each disconnection: stop-light switch; courtesy-light switches; horn relay and wire; ignition switch; head-light switch; radio; accessory switches; dome light; regulator; heater; condensers (which may be at light switch, regulator battery terminal, generator armature terminal, etc.).

This test also checks the condenser across the distributor's breaker points. Slip a piece of paper between the points during the test so they won't touch and give a false indication of leakage.

Test seven. This has a dual purpose—to check resistance and polarity of the secondary system. To prevent operation of the generator during this test, disconnect the lead from the field terminal. Start the engine and adjust it to 1,500 r.p.m. Set the meter switch to normal.

Connect (+) lead to engine ground and contact each spark-plug terminal in turn with the (−) lead. The meter should deflect upscale, indicating low resistance and correct spark polarity. All readings should be the same.

Caution is called for because of high voltage at the plugs. Don't lean against the car body while holding the test probe. It's best to use an insulated clip-on probe.

If *all* readings are very low, it means a corroded coil tower terminal, poorly connected or broken coil wire, burned center cap electrode or rotor tip, or open secondary in coil. If one or more readings are below average, it means broken or poorly connected plug wires, burned or corroded cap terminals, or gouged electrodes inside the cap. If one or more readings are above average, there's crossfire in the distributor cap or between cables to plugs concerned.

Incorrect polarity is easily fixed by interchanging the primary-circuit connections at the ignition coil.

Final tests. Make them inside the car

Continued

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What Weldwood® hath joined together, let no man put asunder.

When you glue something to something else with a Weldwood glue, you can be sure it'll stay stuck.

For example, Weldwood White Glue keeps things around the house and shop glued together. Weldwood Contact Cement bonds instantly, on contact. Without clamps. If you're building cabinets, our Plastic-Resin Glue will make wood joints stronger than the wood itself.

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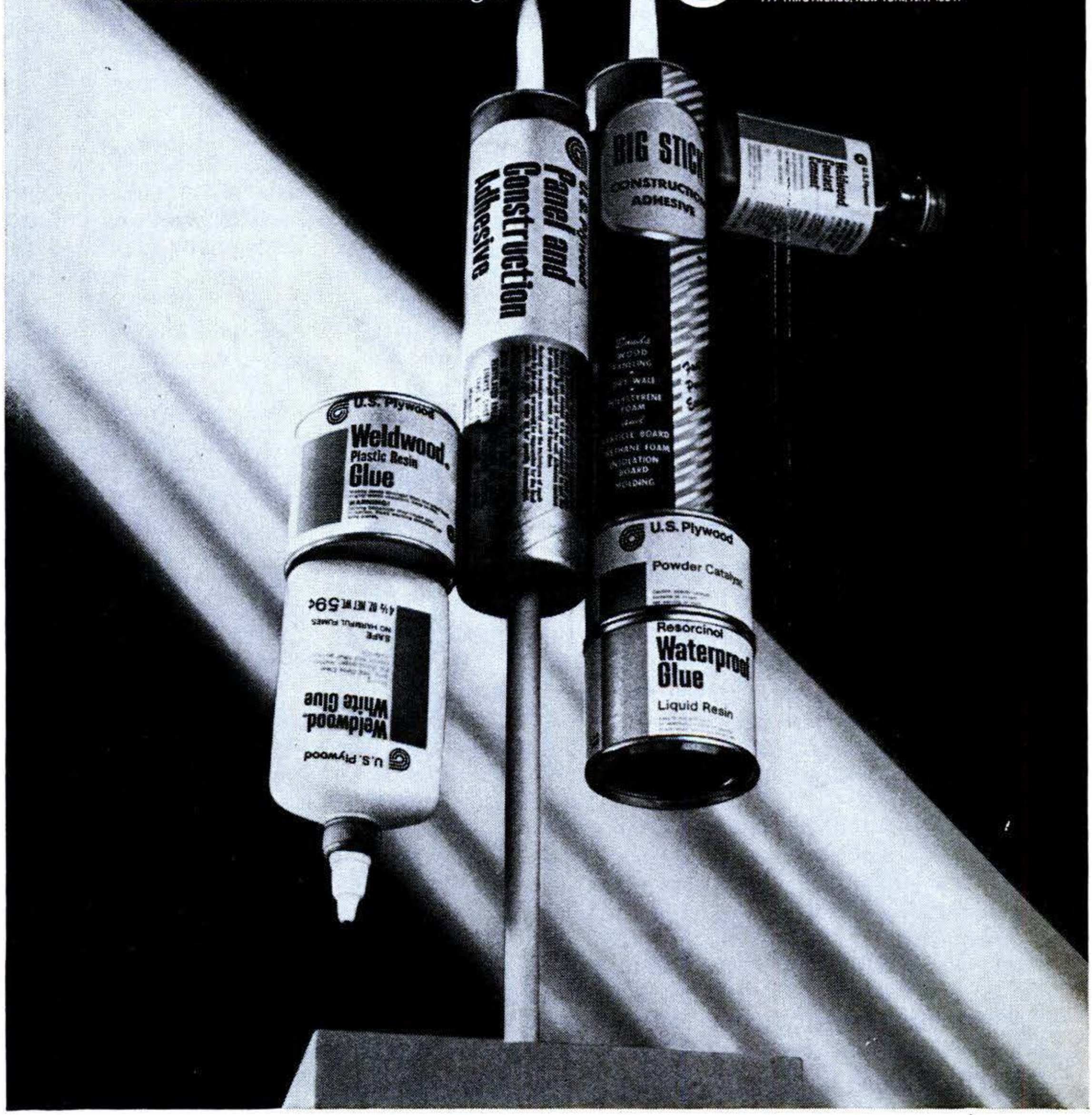

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Build a Voltminder for Your Car

with the meter plugged into the cigar lighter, and the switch set to expanded scale. Note four readings: with the engine off; when you turn on the lights; when you crank the engine; when you let the engine run. Voltages should be: 12 with the engine off; 11.8 with lights on low beam; 9.8 to 10 (on normal scale) when you crank the engine at 70 degrees F.; 12.5 with the engine running. These voltages may vary with battery age and temperature, but serve as a guide.

Assembling the Voltminder. To replace the dial of the milliammeter with that supplied here, lift the meter movement from its case, remove the screws that hold the meter dial, and slide the dial plate from under the point. Cement the new dial over it, with no air bubbles or ragged edges to impede needle movement.

The dual scale is possible because of resistance trimmer controls mounted with two fixed resistors and a Zener diode on a small perforated board that is secured directly to the meter terminals. The trimmer controls are anchored by their own terminals, which are inserted through the board and soldered to leads. Use flea clips as tie points. Be sure both binding posts are insulated from the metal face plate to prevent shorts.

The diode must be the 10-volt type which will prevent the meter, when set for expanded scale, from reading anything until over 10 volts are applied to the input terminals.

Calibrating both ranges. You simply adjust the two trimmer resistors so that given voltage readings correspond to those of an accurate voltmeter. Set the switch to normal range and apply a known DC voltage. Check the reading of the voltmeter and adjust trimmer control R_3 with a small screwdriver until the Voltminder reading agrees. Switch to expanded range and similarly adjust R_4. Switch back and forth between ranges; if correctly calibrated, the Voltminder will give identical readings on the two scales for voltages between 11 and 16.

Your local radio/television shop or garage should be willing to let you use their meter for calibration. But don't be surprised if they ask a return favor. Once they see your Voltminder, they're likely to want one of their own. PS

Get Ready for Your Winter Fun

[Continued from page 127]

tracked unit that resembles an ATV more than a snowmobile. In fact, it can be run on dry ground during the summer. The Ridge Runner turns in its own length by stopping one of its "live-power" tracks. The vehicle has bucket seats, and an optional radio and tape player. Price? Up to about $2,000, depending on whether you select a 28- or 45-hp. JLO engine.

While many sportsmen might appreciate having protection against the wind and cold, most snowmobilers will be braving the elements on standard open vehicles. There are now more than 40 different makes of these.

Snowmobiles come in two sizes: mini and full-size. Mini-machines are about two-thirds the length of standard machines and weigh less than half as much. They are powered by tiny engines, and aren't capable of giving the performance or doing the work, of full-size machines. However, you do get, generally, superior flotation qualities and more maneuverability.

Full-size snowmobiles run from about 90 inches in length to about 110 inches and weigh from about 275 pounds up to almost 500 pounds—for workhorse, utility-type vehicles.

Track width is important. Standard width is 15-15½ inches; medium width is 17-19 inches; and wide-tracks are 20 inches and over. Some snowmobiles have double tracks for even greater traction and flotation. The standard-tracked vehicles are the least stable and require a lot of body English to keep on an even keel, especially around turns.

Wide-tracks and double-tracked vehicles are best in soft snow and on mountainous terrain. They offer a highly stable ride and are less likely to flip. The medium-tracked snowmobiles are a good compromise, giving a more stable ride and better traction through rugged areas.

In their early days, snowmobiles used to be almost spartan in looks and comfort. Now you can buy vehicles with auto-type dashboards, including cigarette lighters, tachometers, speedometers, and handy light switches.

From every standpoint, snowmobiles have really grown up into the kind of vehicles that can make this winter the liveliest you've ever experienced. PS

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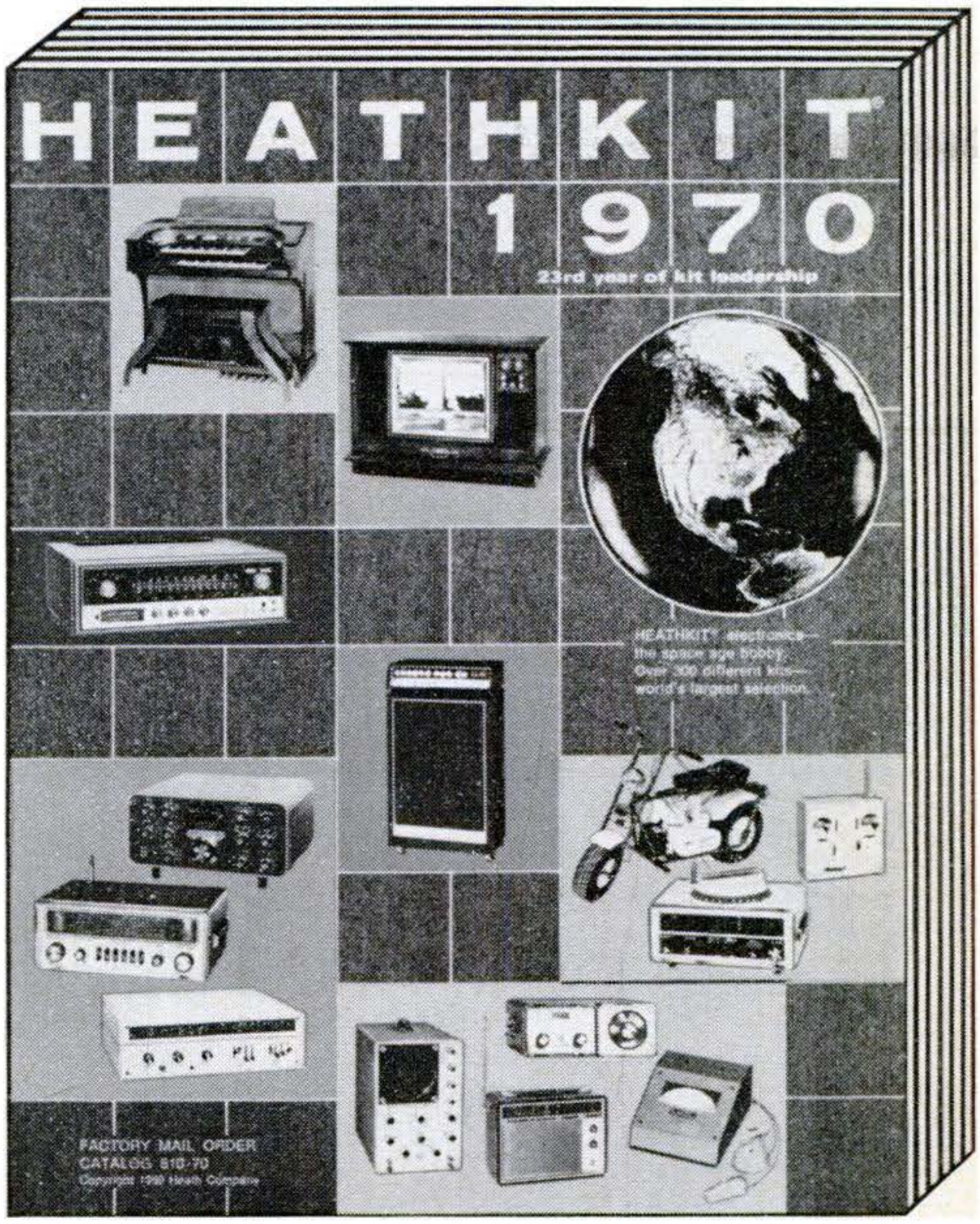

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Our new Rod Saw has no teeth. Instead, it has thousands of permanently bonded tungsten carbide cutting edges.

The rod itself fits any standard 10" hack saw frame But the similarity ends there. Because the Rod Saw cuts through things a regular hack saw blade won't even scratch.

It cuts through spring steel, hardened bolts, welds and cast iron with ease. And because of the tool design, the cutting edges go all the way around the rod. So it not only cuts straight, but also cuts in any direction on brick, glass, flagstone, ceramics, fiber glass, laminates and other hard-to-cut materials. (And does it faster, because it cuts on both forward and backward strokes).

Originally developed for industry, now packaged for home use, the Remington Rod Saw is available at most hardware stores.

You should not have any trouble recognizing it. Just look for the saw without any teeth.

Remington DUPONT

Made in U. S. A. U. S. Patent 3,023,490. Applications pending. Remington is a trademark of Remington Arms Company, Inc., and DUPONT is a trademark of E. I. du Pont de Nemours & Co. (Inc.)

Why We're Going Back to the Moon

[Continued from page 81]

rocks uplifted from as deep as six miles. Flying vehicles, needed to reach high ledges and collect specimens, are expected to be ready by the time of this bold venture in 1972.

Mining the moon. Practical rewards of exploring the moon may soon be illustrated by Apollo 11's precious 54 pounds of moon-rock samples—and others to come from the next moon landings.

One of the 142 scientists eagerly awaiting the first specimens hoped to find diamonds in them—microscopic ones, as in rocks around Meteor Crater, Ariz. But it will be more exciting if tests confirm that moon rocks can yield things like water and oxygen—more valuable than diamonds, on the waterless and airless surface of the moon!

Bureau of Mines experimenters and others have demonstrated ways to extract water from lunar rocks if they contain hydrous minerals common on earth. And "mined" lunar water could be decomposed electrically into hydrogen for fuel, and oxygen to breathe or to use as a rocket engine propellant.

Since Apollo 11, it no longer seems at all visionary to look forward to manned lunar bases, exploiting the moon's advantages for such practical facilities as observatories and spaceports. The potential of such bases would be vastly enhanced, of course, if their oxygen, water, and fuel need not be brought for all eternity from earth, but can later on be obtained near at hand.

Apollo 11's feats pioneer the way. A major activity of coming lunar explorers, decking the moon with scientific instruments, was well begun by Apollo 11. The laser reflector it left behind, located by Lick Observatory after a two-week hunt, will measure the wobble of the moon's orbit with new precision. A "moonquake detector" put on the lunar surface reports a fascinating variety of quivers—of which much more will be learned when other detectors at coming sites provide a whole network.

Returning lunar astronauts will continue to be quarantined as a precaution against the remote possibility of "moon germs." Apollo 11 found no sign of lunar life, nor has preliminary examination of

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Why We're Going Back to the Moon

s moon samples shown evidence of any in ne past. But the sterility of samples craped from the ultraviolet-exposed lunar opsoil does not provide ironclad proof hat deeper-buried strata of the moon, or e that we may possibly find there, will e equally devoid of any microorganism.

Learning moon-walking. For coming oon explorers, one of Apollo 11's most ncouraging feats was to show the ease f walking in the moon's low gravity, ⅙ at of earth's. Not every spellbound iewer of the astronauts' prancing steps nd "kangaroo hops" realized he was vatching a key scientific experiment. How o move about on the moon's surface had een a controversial and much-debated uestion.

One scientist thought grasshopper-like eaps five yards long would be best. Anther, who feared humans on the moon ould have to learn to walk all over again, oubted men could keep their balance vithout the aid of a walking staff—a cumersome handicap to would-be explorers. hose theories evaporated as Armstrong nd Aldrin stepped forth on the lunar surace, cautiously at first and then with rowing confidence.

Hopping with feet together did work, hey reported—but easiest of all was that trange slow-motion lope that now appears o be the lunar version of normal steps on arth. In a few dramatic moments, before V watchers' eyes, man learned to walk he moon.

The lessons will soon be applied by pollo 12—which will try to land near our nmanned soft-landed Surveyor 3 spaceraft of 1967. This time the astronauts vill moon-walk much farther from their raft, perhaps 1,000 feet or more. Given a inpoint landing, that may allow them to isit and inspect the Surveyor, and even ring back a detached part to study. earning what happens in two years to aparatus exposed on the moon would help ngineers design long-lived instruments to ut there.

Apollo 12's astronauts will make two orties on the lunar surface—each longer han Apollo 11's single 2½-hour one. hus will begin the lengthening of time llowed for lunar exploring—which will inrease, more and more, with succeeding xpeditions. PS

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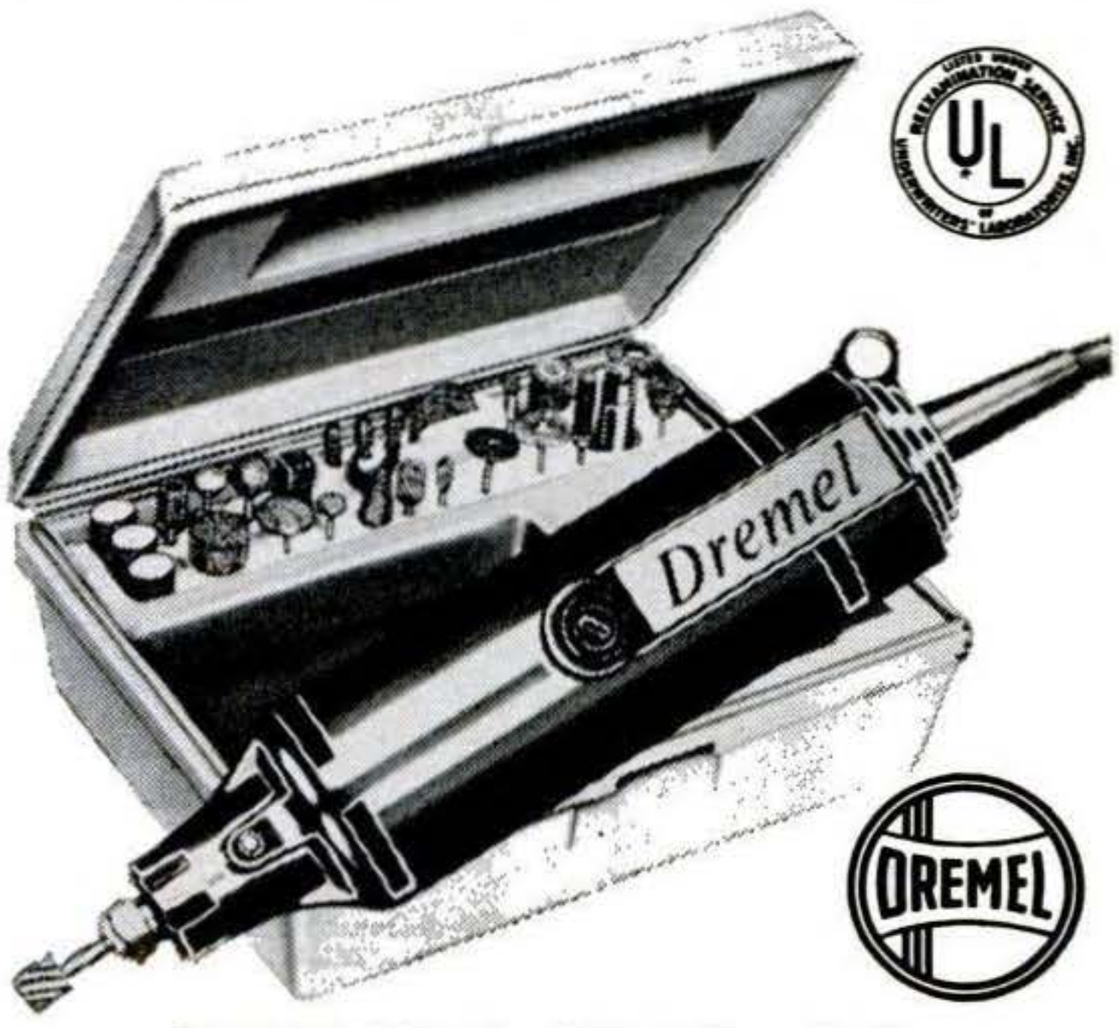

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Vortex Promises Mower Revolution

[*Continued from page 87*]

prototype, a side discharge chute at the rear top of the reel blows the clipped grass away from you. If grass clippings are objectionable, you can attach a catcher bag to the chute.

The reel-vortex blades move at only 8,000 to 9,000 feet per minute. But the forward movement of the blade combined with the aerodynamic action doubles the effective cutting action of the blade. In contrast, the blade tips of rotary mowers whirl at 19,000 to 23,000 feet per minute. Even at the lower speed a blade can send an object it hits flying out in any direction at nearly the speed of a bullet.

In one demonstration, Dr. Ferguson reports that he placed six pieces of heavy-gauge aluminum wire on grass and ran his mower over them. The wires, bent so they would stick up into the reel, were thrown out the front of the mower at a speed too low to cause serious personal injury. Five simply dropped in front of the mower.

In another demonstration, a reel-vortex prototype with 3½-hp. engine and a 21-inch reel cut four-inch-high grass as neatly as a conventional-reel mower cuts shorter grass. The air flow, which lifts the grass and blows it against the cutting blade, results in a sharp, razor-like cut with no ragged edges to turn brown. The reel vortex also went over rough ground, through dense weeds, and through three-foot-high hay at nearly normal pushing speed. The engine did not slow down appreciably under any of the loads.

The reel vortex is not simply a glorified conventional-reel mower. The typical reel model has a five-bladed reel whose bottom throws grass—and occasionally other things—back at the operator. It also has a stationary-bed knife over which the grass must be drawn to be clipped. The knife is set at a close tolerance, and twigs are easily caught between it and the blade, sometimes throwing either the blade or knife out of adjustment.

About 50 prototypes of the reel-vortex mower have been built, using a variety of power plants. One has been built for use with a garden tractor. Licensees will, if they decide to go into production, develop a specific product line incorporating the reel-vortex design. PS

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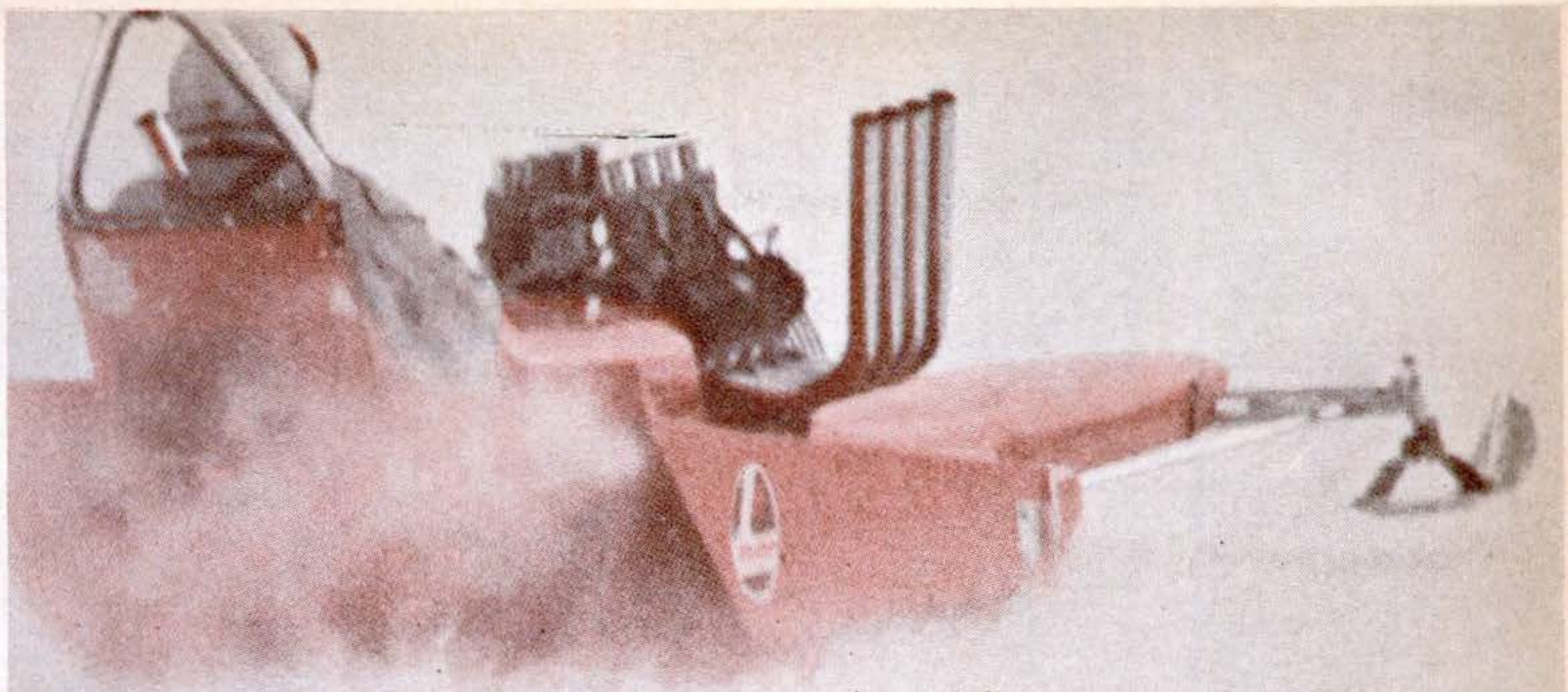

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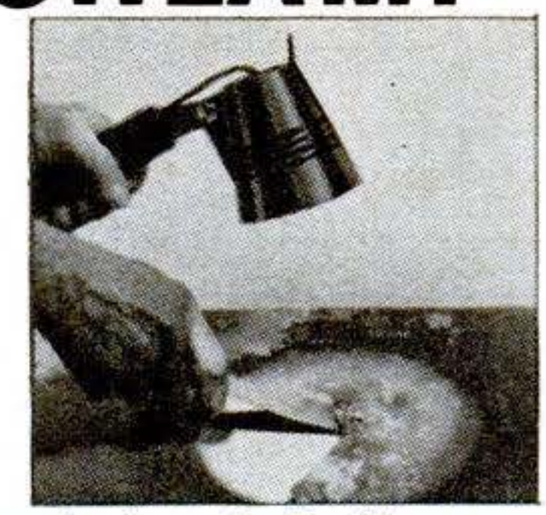

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Safer, Cleaner, Better: The '70 Cars

[*Continued from page 99*]

and rerouted through the engine. Ford ~~also~~ has an engine with this system. Chrysler claims that vapors routed into the engine are no more harmful nor dangerous than raw gasoline wiped into the crankcase by piston rings, a common occurrence. Ford admits there's a higher risk of oil contamination. Nobody's willing to talk about the explosion risk.

Durability and repairability. There are really two different routes to arrive at easier maintenance and cheaper and fewer repairs. One is to make it easier for the car owner to do his own work. The other is to make big repair jobs easier and thus cut the time a vehicle spends in the shop.

For lengthening engine life, Oldsmobile's valve rotators are the hottest thing in years. The development promises to eliminate the need for a valve job until the whole engine goes in for overhaul.

The valve rotator works as a one-way friction clutch, and also acts as a valve-spring retainer. During each opening-and-closing cycle, it turns approximately two degrees. The valve sealing surfaces are polished to a clean, mirrorlike finish.

Other advances: Buick has its own version of Cadillac's semiclosed cooling system, which not only gives more effective cooling but also lets you refill the coolant without removing the pressure cap.

Cadillac has a new one-piece steering knuckle that integrates six separate pieces to improve reliability and durability. It also has its first new-design axle in 30 years. This is quieter, more durable, but most important, has a higher torque capacity to handle the power of the big Caddie engine.

Hornet has bolt-on front fenders for ease of repair and replacement, and a central fuse panel on the firewall. The instrument cluster can be removed as a single unit by removing four screws. Headlamps on Hornet, Cougar, Maverick, and Mark III are adjustable without removing sheet metal or bezels.

Conclusion: Far from swinging towards the cheap, mass-produced, expendable, no-return car package that some industry critics talk about, Detroit is actually building cars that will run better for a longer time, give more satisfaction and safety, and can be fixed when defective. PS

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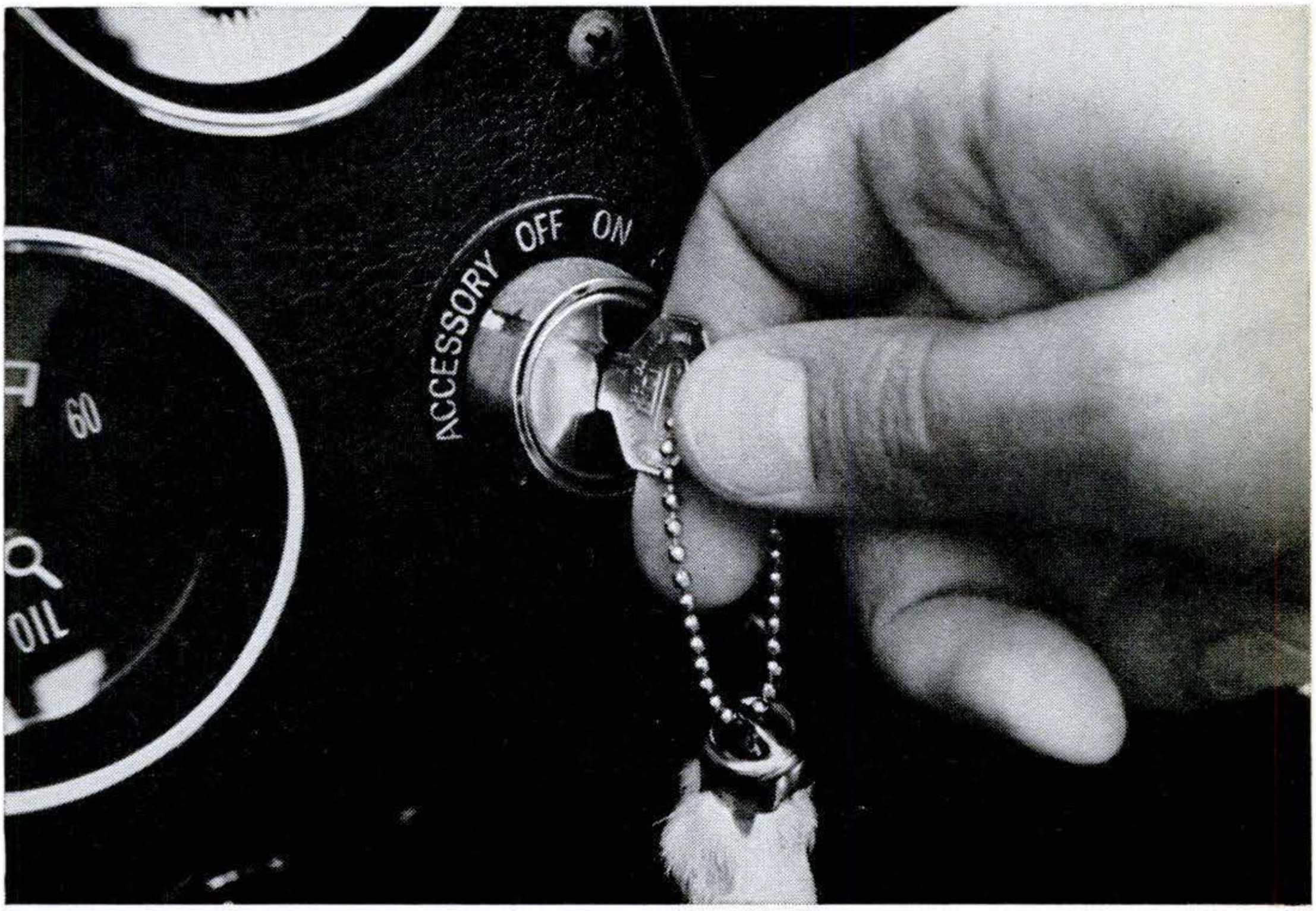

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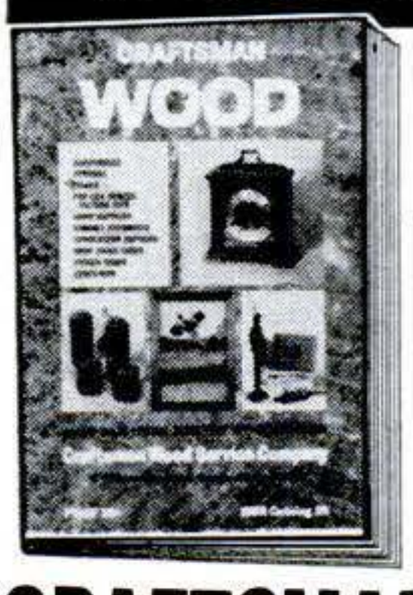

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[Continued from page 145]

circuit, like an unseen hand on the tint control, automatically corrects for hue errors within a portion of the spectrum.

The TV industry is trying to eliminate those hue errors by standardizing its color signals at the transmitting end, but so far they've arrived at no solution. Until they do, an automatic tint control can be a welcome addition.

Good-bye to the click. One of the most abused components in the TV set—the channel-selecting tuner—has also been upgraded, and silenced. Inside the standard tuner there are usually eight metal humps that nestle against eight springlike contacts. This arrangement connects all the coils needed to receive one station. A year or so after you buy your set, though, springs loosen and dirt coats the contacts. Snow creeps into the picture, or you maybe have to hit the channel knob to restore the picture. Several types of electronic tuning in new sets now eliminate the moving parts—and the clicks—and most of the problems.

RCA's new tuner, for example, is "diode-switched." Its four integrated circuits switch channels electronically—there's no mechanical motion. The system also makes possible a remarkable new remote-control system that instantly, and silently, flashes any desired channel on the screen.

A similar approach for volume, tint, and other remotely controlled circuits enables RCA to eliminate four electric motors from its new chassis. If you want this degree of sophistication, it's available in RCA's 2000 model at $2,000. The company says it's making only 2,000 of them.

Another attack on a tuner's moving parts is Panasonic's Electro-Tuning. You select channels merely by depressing two controls (left-right), which cause the tuner to automatically scan all channels. When the desired program appears, you release the key and the circuit automatically fine-tunes the station.

Panasonic has also demonstrated a new "varicap" tuner that enables you to select channels with pushbuttons—like choosing a station on a car radio. The circuit is still experimental, but could go into production shortly.

Just how far electronic tuning can go was described at a recent technical convention. Two engineers of the Fairchild Semiconductor Company predicted that we'll select channels with barely a wave of the hand. It'll work like the "touch-tone" system you may have seen in the telephone ads.

Those are the blockbusters for 1970. But behind the front panels there are many circuit refinements that make for better pictures and fewer repairs.

Tribridization. In the rush toward solid-state design, many of today's sets are "tribrids," meaning that circuits include three basic types of construction—vacuum tube, transistor, and IC (integrated circuit). The reason for the mishmash is that new sets are in the midst of a changeover that's knocking out vacuum tubes (which cause 80 percent of TV troubles) and replacing them with solid-state devices. An IC takeover from transistors later in the decade is expected to complete the transition, making sets smaller, lighter, and less prone to breakdown.

Modularization. Motorola won wide acceptance with its Quasar (works-in-a-drawer) model introduced not too long ago. In fact, the easy-service idea has been so successful that the company is feeding it down to lower-cost chassis. The earlier Quasar console with a 23-inch screen started at $600; the new 20-inch set will also have its works-in-a-drawer, but will sell for $500.

A variation of the idea also appears in several new Motorola black-and-white portables for 1970. Their chassis slide out the back for fast servicing. Similar easy-service concepts are being adopted by other makers. RCA has plug-in circuits that can be yanked from a chassis in seconds. Zenith is introducing its Dura-module. Other manufacturers are trying plug-in transistors (as opposed to soldered-in types) to ease the serviceman's job (and save you money).

On the boards. What's next for TV? Designers are talking about dramatic new approaches in set design—from a flat receiver you can hang on the wall, to an image glowing in 3-D color. They'll need five or more years, however, to bring such sets to market. In the meantime they can point to a much-improved product to start off the Seventies. PS

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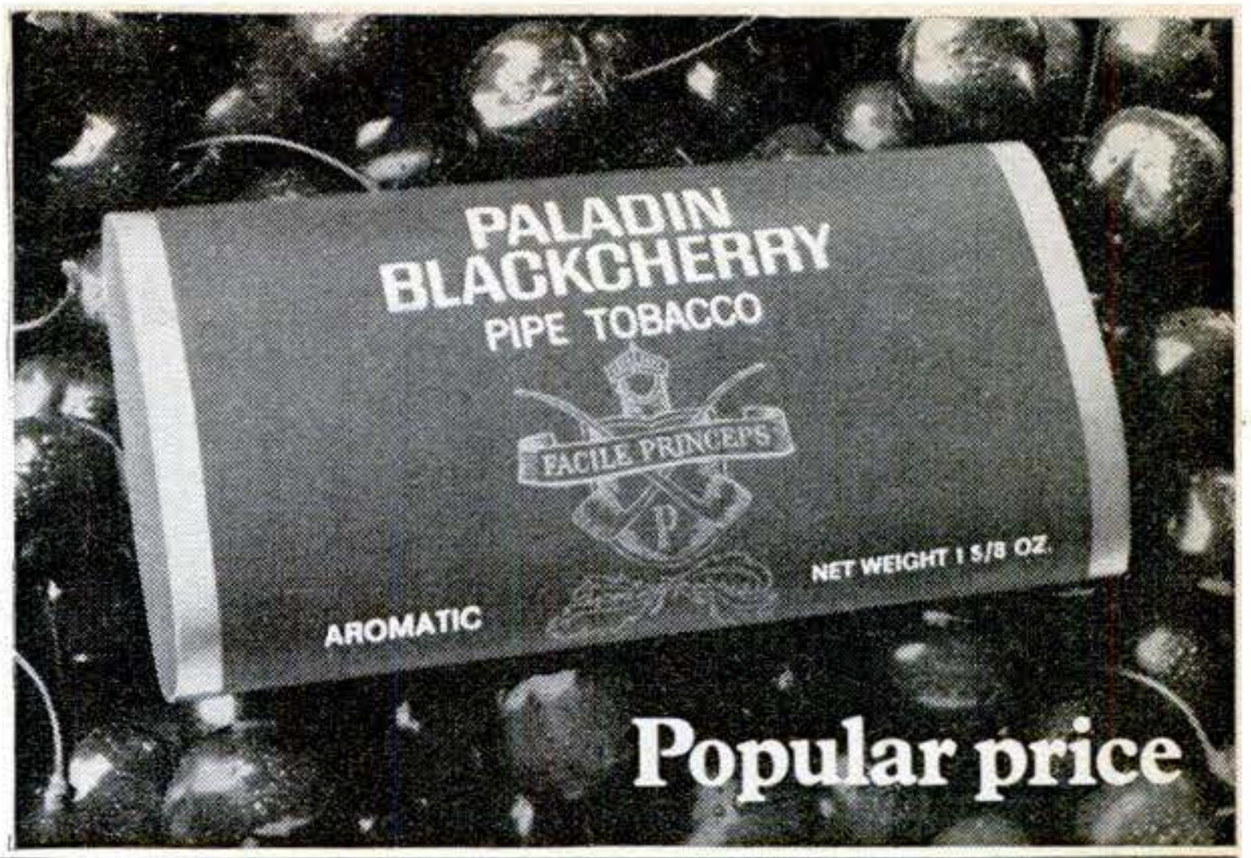

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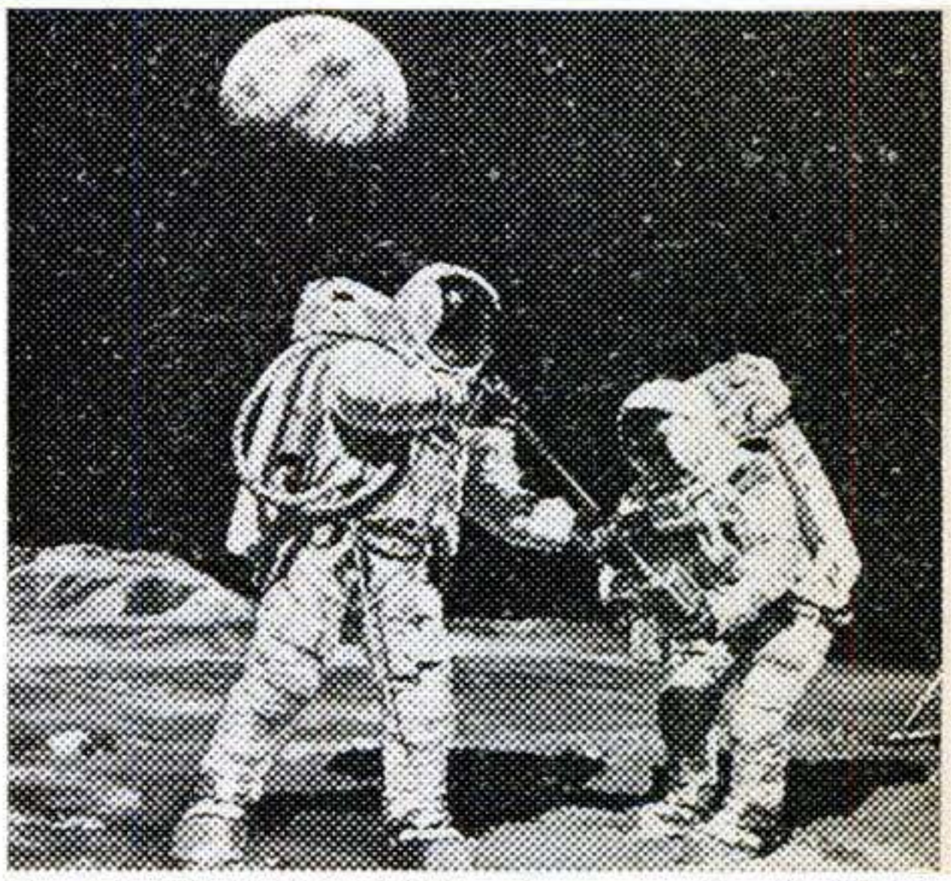

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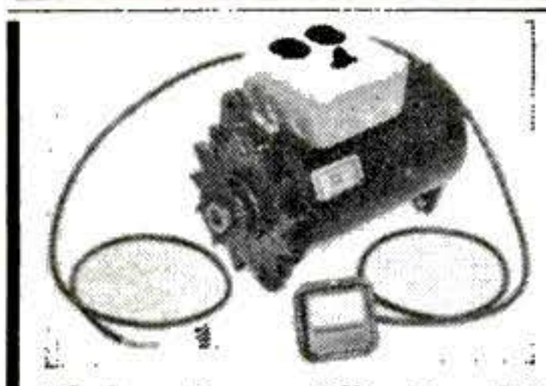

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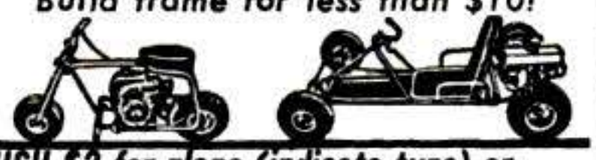

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Sleek New Private Planes from Abroad

[*Continued from page 91*]

inner skin is made of a series of small fiberglass tubes that run parallel to the wing ribs. The tailplane is one piece; all moving parts and the trailing edges of the rudder and tailplane have balsa-wood cores. Gear is retractable tricycle. Weight is about 1,500 pounds empty; cruising speed with 200-hp. Lycoming is 186 m.p.h.

LFU reports one wing was subjected to dynamic loads equal to 36,000 flight hours without cracks or evidence of fatigue. The experimental research plane is being developed by several German firms, including Messerschmitt-Bolkow.

The Czechs, with a well-earned reputation for producing winning aerobatic planes, are producing a family of light craft aimed at trainer markets. This year, the Moravian Aircraft Factory showed a two-place Z-42 and a four-place Z-43 low-wing (both all-metal planes) that had 80 percent common parts.

The two-seater, stressed for aerobatics, is powered by a 180-hp. M137 Walter engine; the four-place, which is also aerobatic, uses a 210 M337 Walter engine. First production models of the two-seater are to be available this year; the four-seater is scheduled for 1971 deliveries. The Czechs plan to market in the U.S.

Aerobatic sport flying. There is increasing evidence of new interest in aerobatic sport flying in the U.S. Beech has a fixed-tricycle gear aerobatic Musketeer for about $15,000, and an aerobatic Bonanza for $40,000. Champion Aircraft has a two-passenger Citabria at about $10,000. And German-manufactured Bolkow Junior, with a base price of about $8,000, has limited aerobatic capabilities. It is marketed in the U.S. through Pioneer Aero Service of Glendale, Calif. This plane was originally a home-built designed by an American Convair engineer. A Swedish company bought the manufacturing rights and then a German company did, too. It is the German version that is marketed in the U.S. The 100-hp. plane has a wingspan of 24 feet and cruises at about 130 m.p.h.

Both Europeans and Americans hope that there are new small planes about to take wing that will be still cheaper, and still easier to fly. PS

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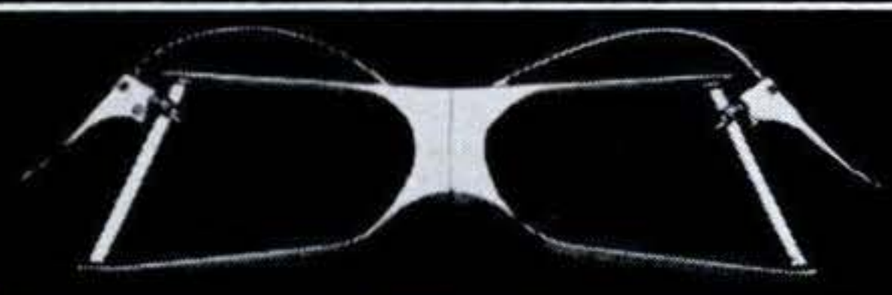

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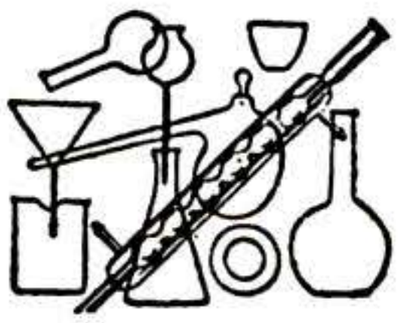

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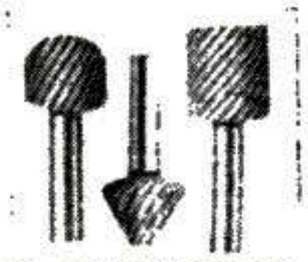

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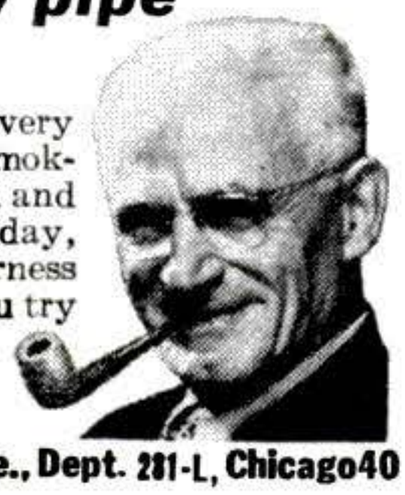

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Thunderbolt Machine

[*Continued from page 85*]

Lightning-proofing an airplane. Power-line components are not the only targets of GE's thunderbolt machine. It is helping, too, to safeguard today's aircraft from lightning.

Surprisingly, jet liners may be more vulnerable to lightning now than ever before. They use transistors and solid-state integrated circuits in ever-increasing numbers in radios, direction finders, navigation systems, automatic-landing devices. These electronic aids, designed to work at low voltages, are easily damaged by higher ones.

A hit (or near-miss) by a lightning bolt can send current surging through a plane's internal wiring by induction—and the result could be another unexplained aviation disaster.

For major aircraft makers and government agencies, GE's Ultra High Voltage Lab is seeking answers. Its researchers are blasting airplane wings, fuselages, and other parts with artificial lightning from impulse generators, including the new outdoor one. They look for two kinds of damage. One is mechanical—holes punched or burned in the skin, broken windshields or radomes. The other is subtly hidden electronic damage that could cause a crash.

"Now we can test an *entire airplane* at one time, using our new outdoor facility," I was informed by J. A. Plumer, sales manager of the laboratory.

Nuclear-blast effects, too. Another major role of the outdoor lab will be to simulate the electromagnetic pulse emitted by a lightning stroke or a nuclear explosion. Although this radiation is a comparatively minor part of a nuclear blast, compared to energy released in other ways, it can travel far and do real damage. Electromagnetic-pulse tests are of enormous interest to government and industry. They show how much of this radiation our rockets, missiles, aircraft, and other machines can take and still stay in business.

So while the new proving ground's equipment looks like science fantasy, its goals are decidedly practical—cheaper electric power through more efficient power transmission, and protection from natural and man-made lightning that can play hob with our geared-to-electricity way of living. PS

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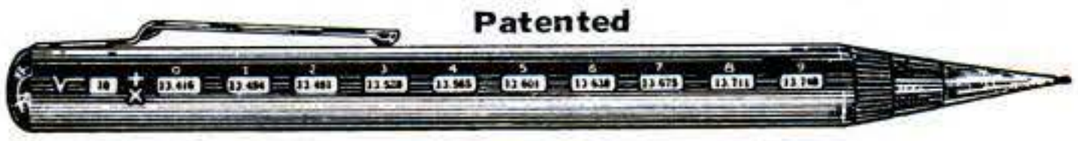

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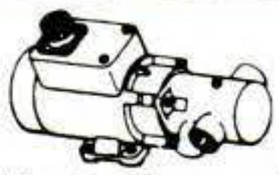

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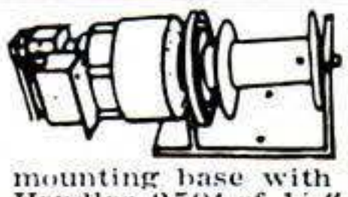

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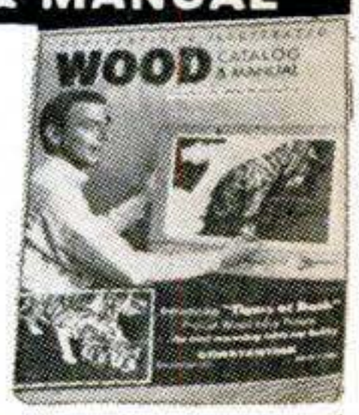

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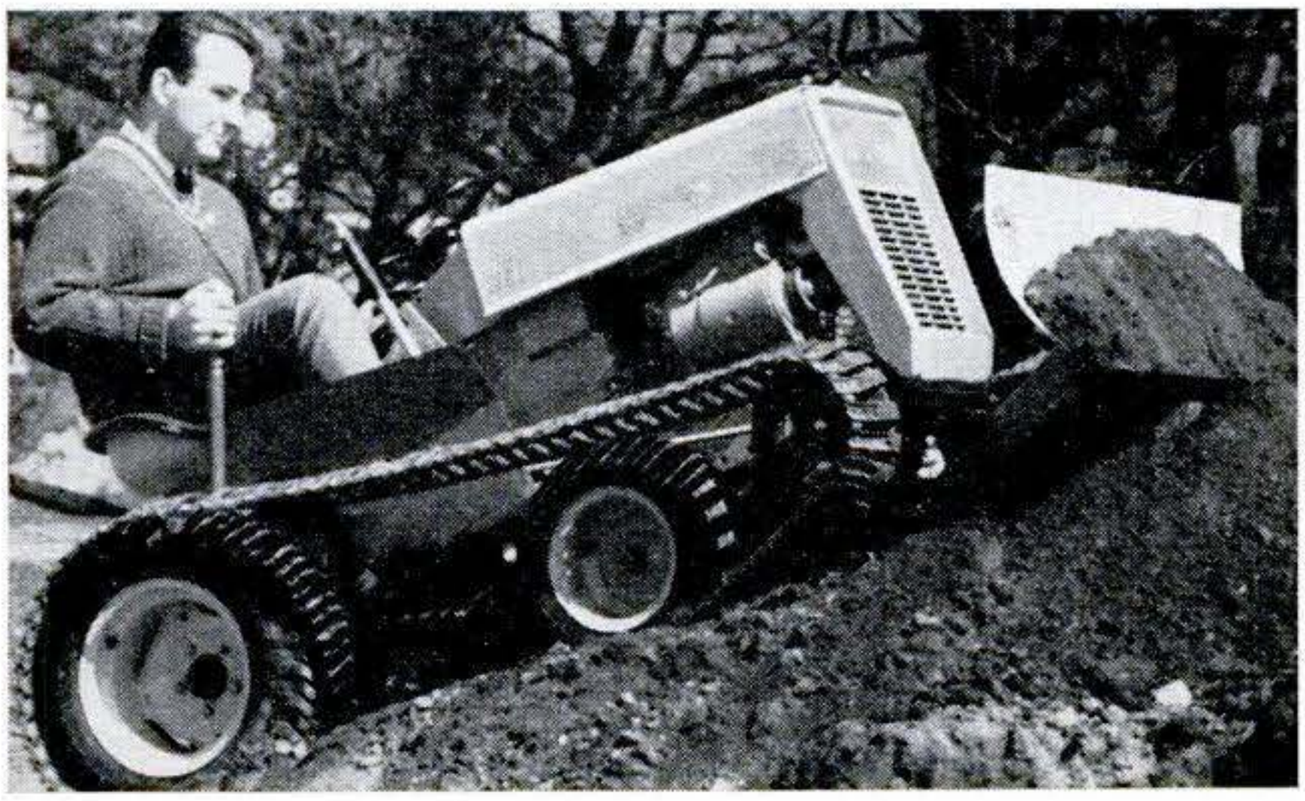

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[*Continued from page 95*]

on the little printed-circuit bridge could be randomed at the factory; this would give the thief the same chance of hitting the correct values as he had of winning a lottery. But the inventor was a professional and tried to think what a thief could do to his device.

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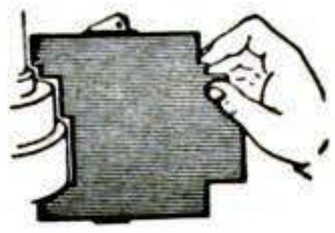

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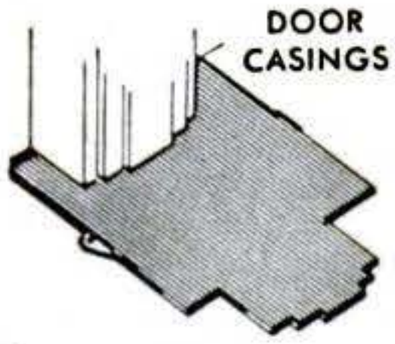

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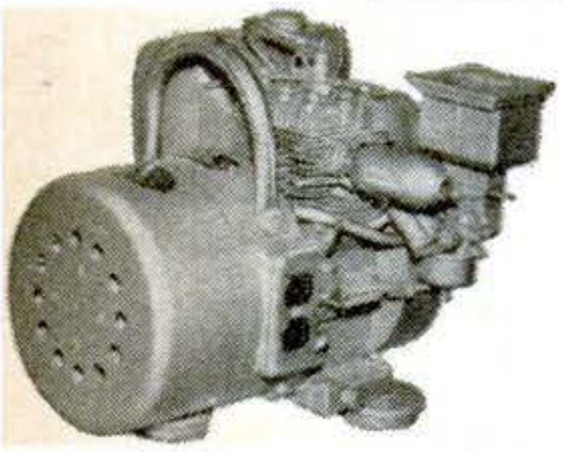

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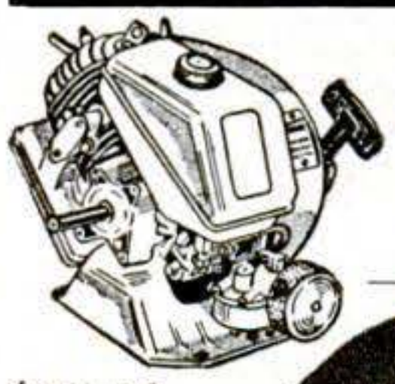

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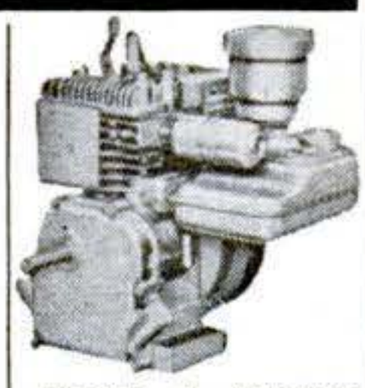

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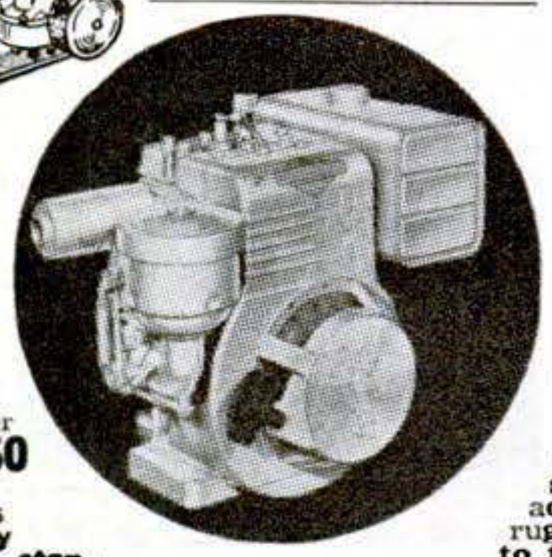

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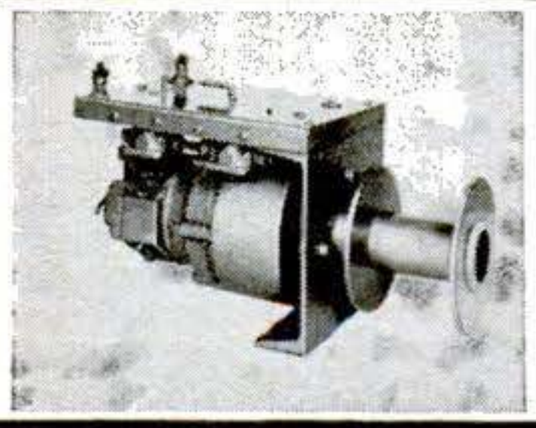

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C			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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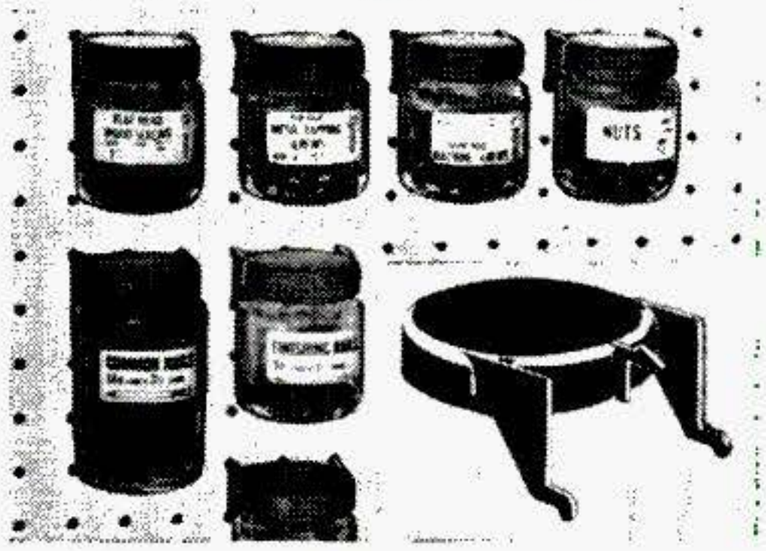

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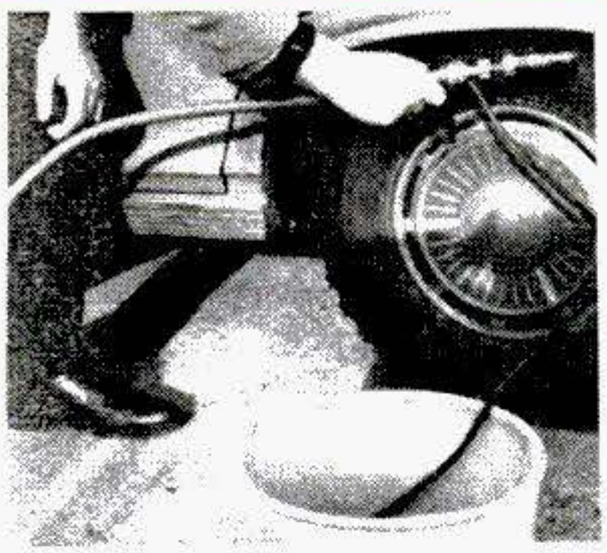

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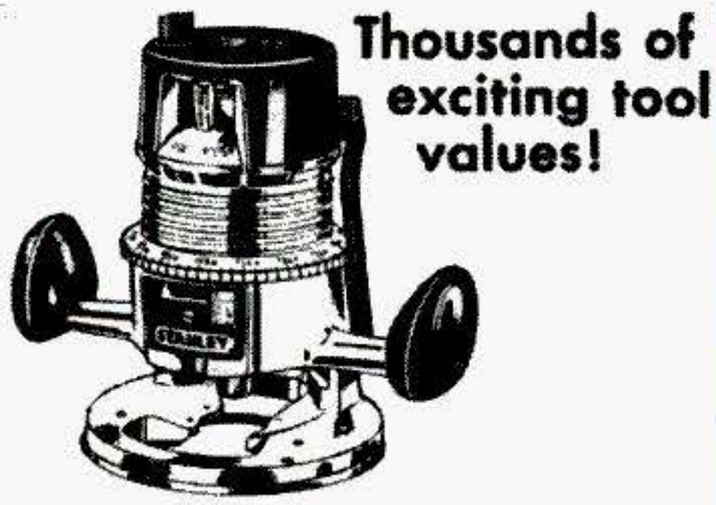

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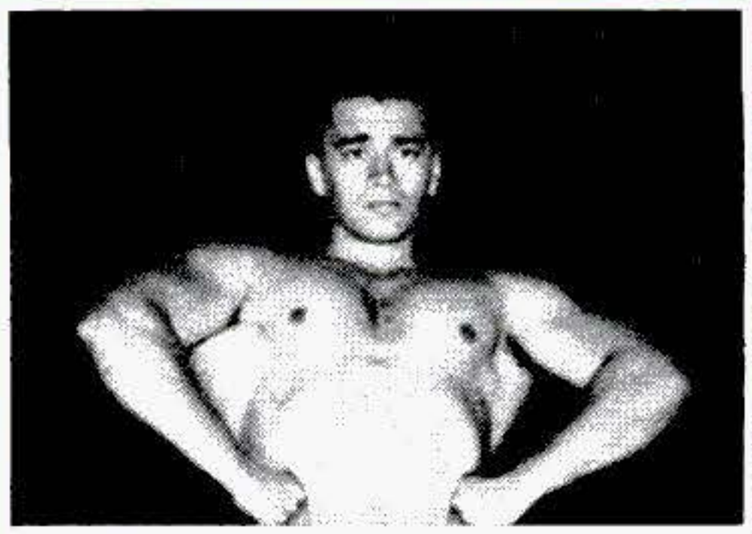

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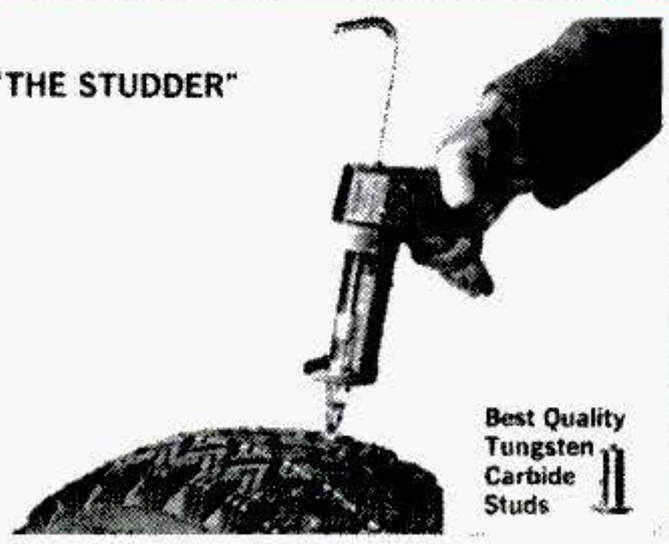

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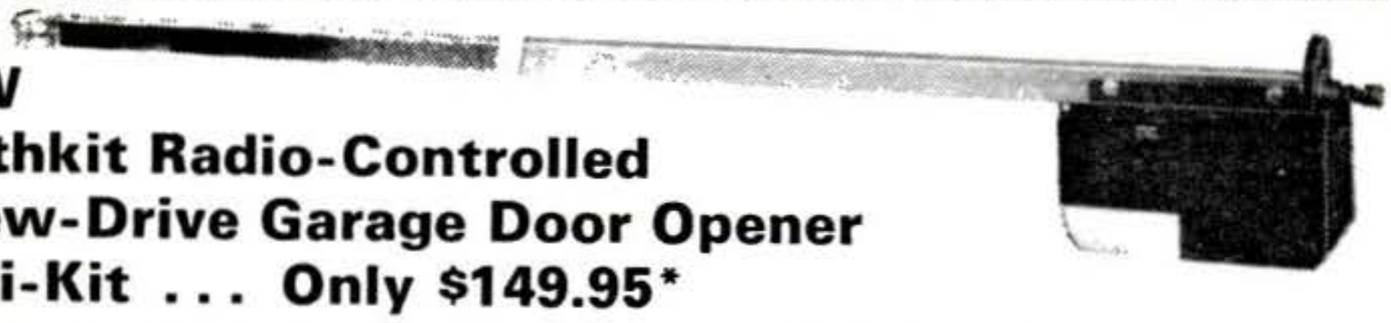

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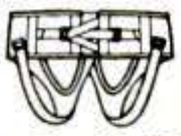

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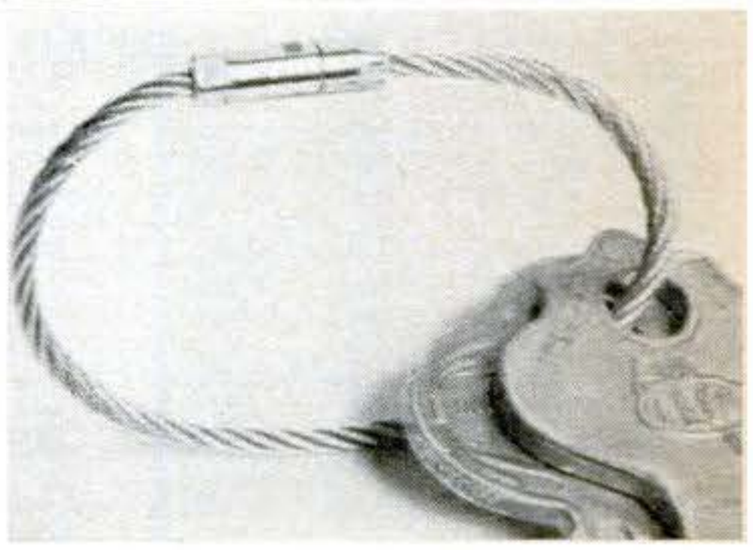

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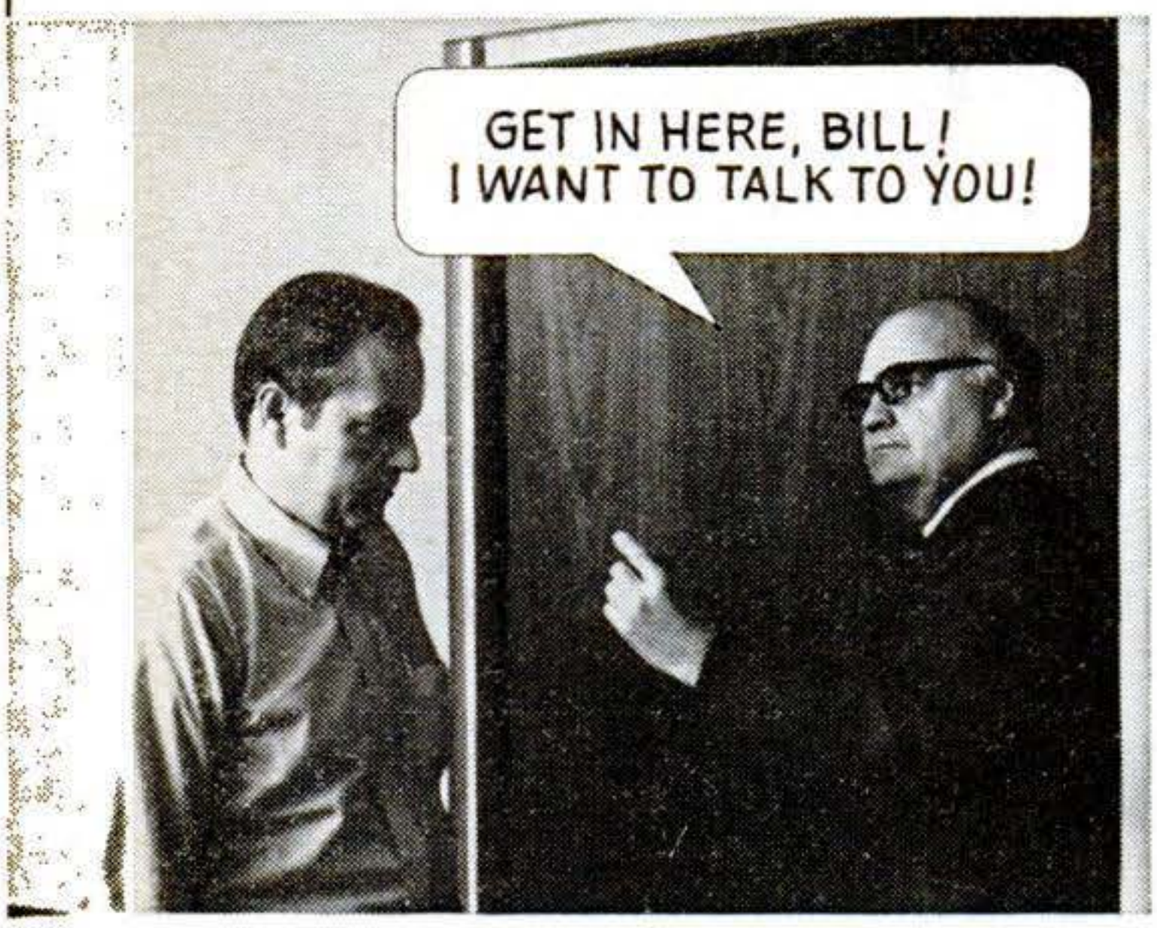

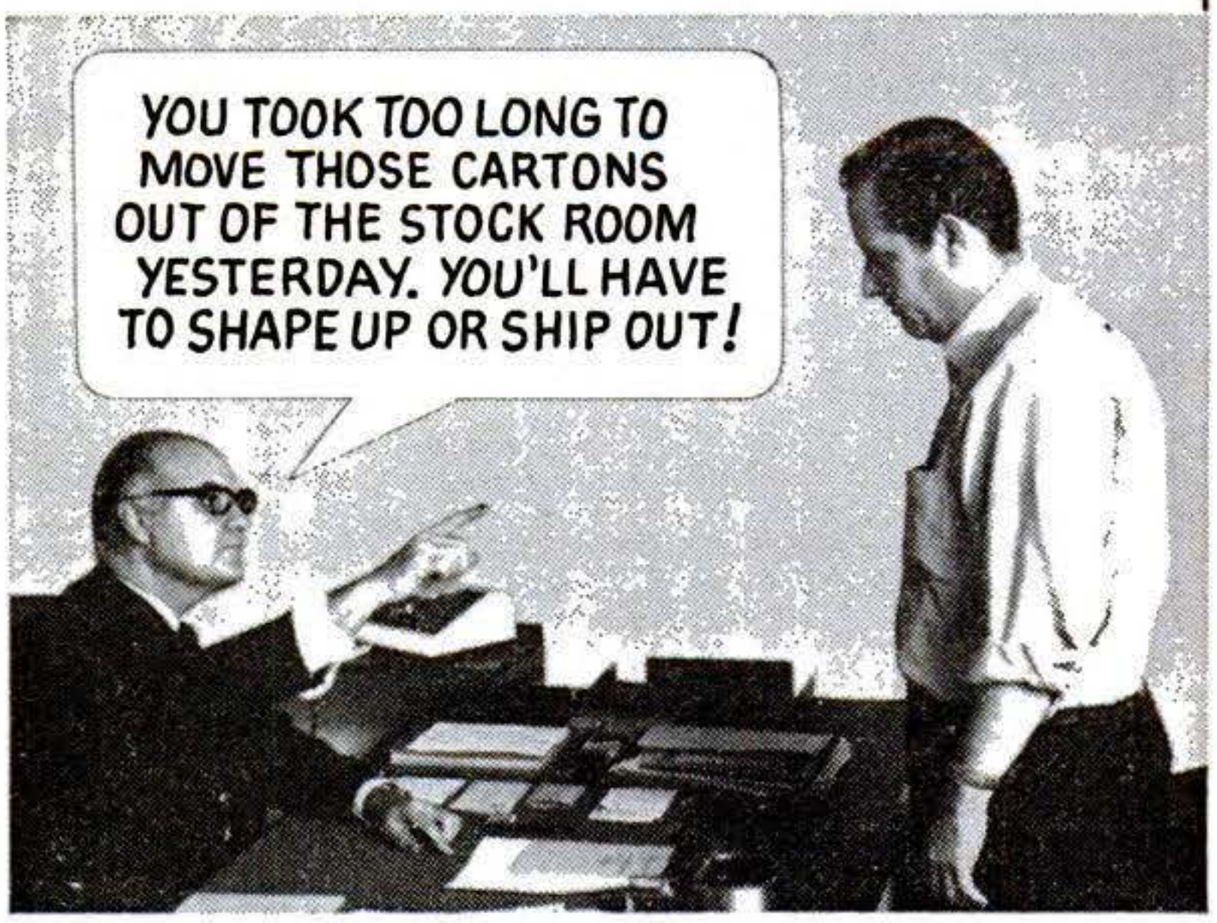

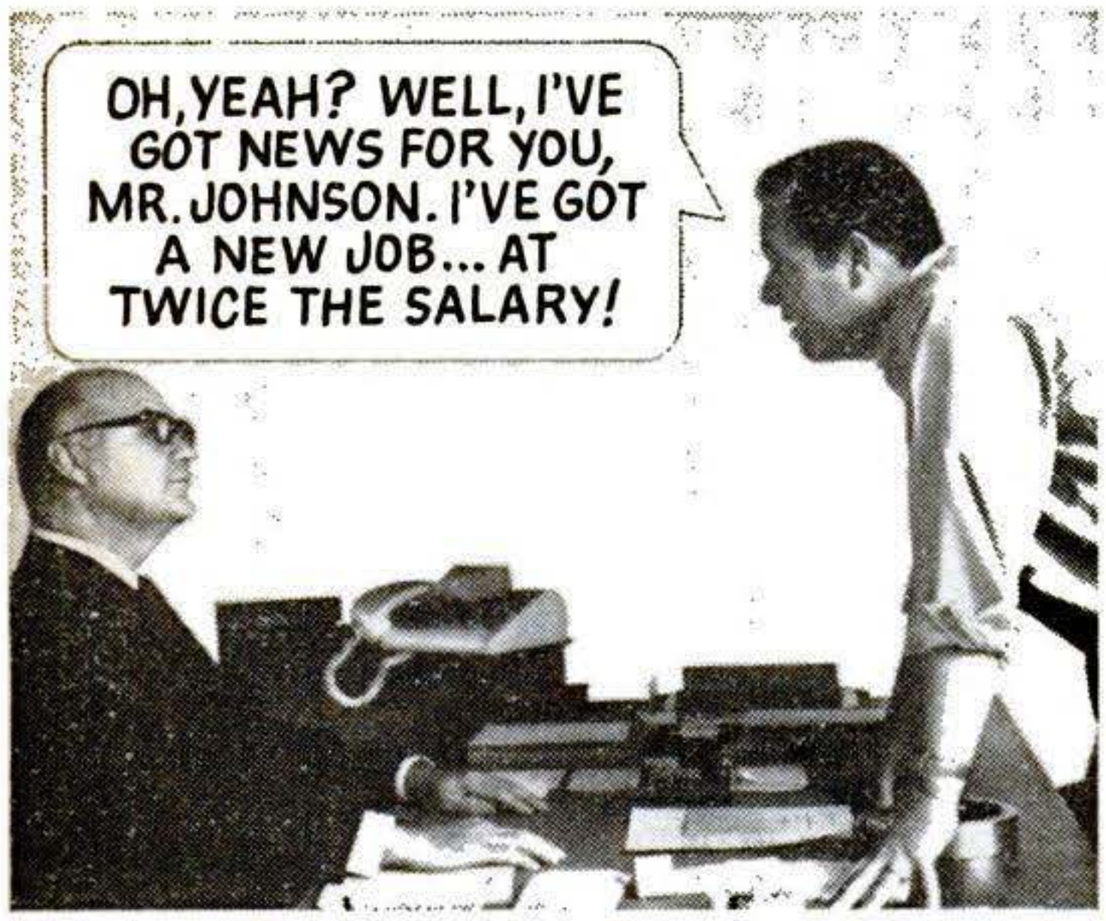

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